PUBLICATION 383
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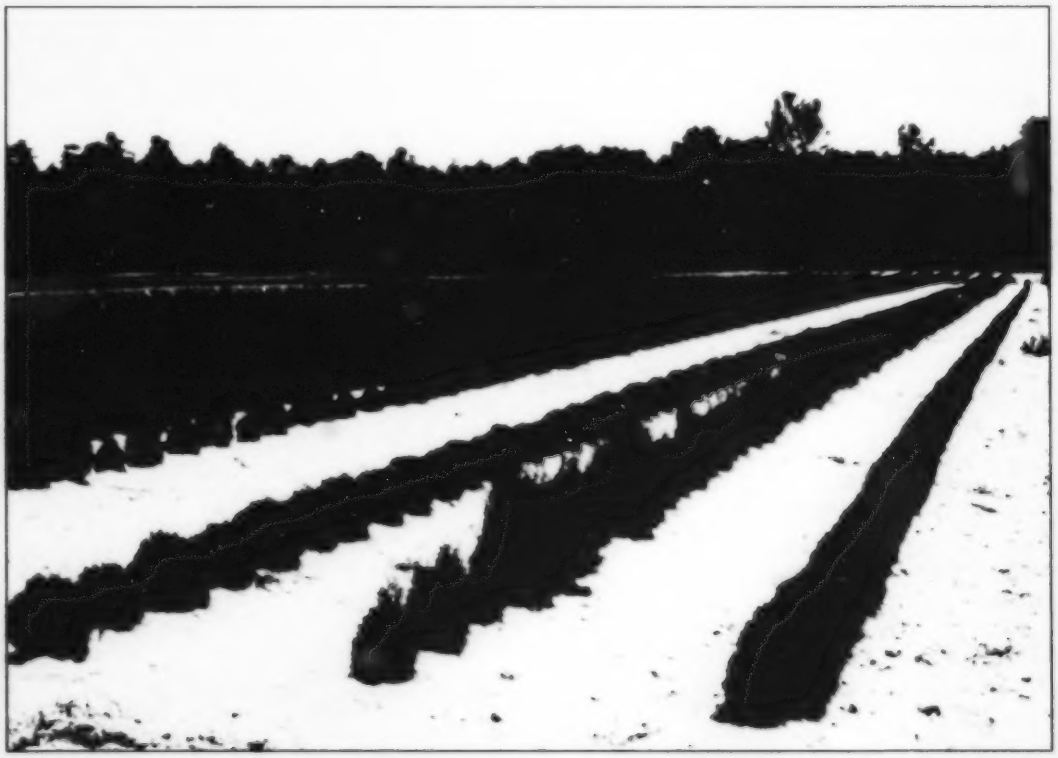
PRODUCTION RECOMMENDATIONS FOR NURSERY AND LANDSCAPE PLANTS



Ontario
Ministry of Agriculture and Food

92-04927/

To the best of the collective knowledge of the members of the Ontario Crop Protection Committee, all pesticides listed in this publication were federally registered, reviewed by the Ontario Pesticides Advisory Committee and classified by the Ministry of the Environment as of November 8, 1990.

The information presented on the pesticide container label regarding application rates and methods of application is the final authority and where conflicts occur between this publication and the container label, the latter applies.

PAY CLOSE ATTENTION TO ALL INSTRUCTIONS AND WARNINGS PRINTED ON THE PESTICIDE LABEL.

The Ministry of Agriculture and Food, or the Ontario Crop Protection Committee by printing this publication does not offer any warranty or guarantee and they do not assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

POLICY STATEMENT

In this publication, most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the more toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that, in some cases, the most effective pesticides are highly toxic.

Weather and other factors influence the effectiveness of pesticides and the likelihood of plant injury by control chemicals. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluble powders (WP or SP) generally are less likely to cause plant injury than liquid concentrates (EC, SC, and F).

A number of brand names of pesticides are given in the calendars as a convenience to the grower and are neither an endorsement of the product nor a suggestion that similar products are not effective.

The pesticide recommendations are reviewed annually by the Ontario Crop Protection Committee. **OLD EDITIONS SHOULD BE DISCARDED.**

For additional information or clarification of recommendations, contact Ontario Ministry of Agriculture and Food personnel listed on page 2.

FEDERAL REGISTRATION AND PROVINCIAL CLASSIFICATION

Ontario's Pesticides Act and Regulation 751, administered by the Ministry of the Environment, prohibits the sale and use of pesticide products unless they are registered under the federal Pest Control Products Act and classified under the provincial Pesticides Act by being placed in one of six schedules of the Ontario regulation.

FEDERAL REGISTRATION

There are three categories:

1. **Full Registration**
   Implies that all federal departments involved in the registration process agreed that the data package was acceptable at time of registration.
2. **Temporary Registration**
   Indicates that there is a need for additional scientific or technical information to acquire a full registration. Temporary registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use in the following year.
3. **Temporary Registration (Restricted Class)**
   Indicates that there is an urgent need for the pesticide but that studies on the safety of the product are incomplete. Such registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use the following year.

PROVINCIAL CLASSIFICATION

Pesticide products are classified into six schedules in Regulation 751 on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration and usage. This classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario.

The pesticide products presently carrying temporary registration may or may not be classified and available in Ontario in 1991.

For updated information of the regulatory status of these or other pesticides contact the Pesticide Section, Hazardous Contaminants Coordination Branch, Ministry of the Environment, Toronto. Telephone (416) 323-5095.

The pesticide recommendations in this publication are for commercial plantings in Ontario. Home gardeners should use products and methods recommended in Ontario Ministry of Agriculture and Food Publication 64, *1990-1991 Insect and Disease Control in the Home Garden.*

ACKNOWLEDGEMENTS

The recommendations contained in this publication have been prepared in consultation with:

— Ontario Crop Protection Committee
— Ontario Horticulture Crop Research & Services Committee
— Ontario Soil Management Research Committee

and personnel of:

— Plant Industry Branch, Ontario Ministry of Agriculture and Food
— Ontario Agricultural College, University of Guelph
— Agriculture Canada
— Ontario Ministry of the Environment
— Royal Botanical Gardens
— Ontario Ministry of Natural Resources
— Ontario Ministry of Labour
— Health and Welfare Canada
— Horticultural Research Institute of Ontario

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ONTARIO MINISTRY OF AGRICULTURE AND FOOD

HORTICULTURAL CROP ADVISORS

Area Served or Specialty	Name	Address	Phone No.
Eastern Ontario	Kevin Schooley	College of Agricultural Technology Kemptville, K0G 1J0	613-258-8359
Prince Edward, Hastings, Lennox, Addington, Frontenac	Allan Moynes	P.O. Box 470, Picton, K0K 2T0	613-476-3224
Northumberland, Peterborough	Dave Ridgway	P.O. Box 340, Trenton, K8V 5R5	613-392-3527
Durham, Victoria, York	Tom Clarke	234 King Street East Bowmanville, L1C 1P5	416-623-3348
North York (Bradford Marsh Area)		Muck Research Station R.R. #1, Kettleby, L0G 1J0	416-775-3783
Simcoe, Dufferin, Grey	Ken Wilson	P.O. Box 69, Clarksburg, N0H 1J0	519-599-2042
Halton, Wellington, North Wentworth, Peel	Joe Uyenaka	R.R. #1, Ancaster, L3Y 3K9	416-527-2995
Niagara Peninsula	Burke McNeill	Vineland Station, L0R 2E0	416-562-4142
Haldimand-Norfolk, Brant	Jody Bodnar Steve Rowe	P.O. Box 587, Simcoe, N3Y 4N5	519-426-7120
Oxford, Elgin, Perth, Waterloo	Keith Priest	P.O. Box 666, Woodstock, N4S 7Z5	519-537-6621
Lambton, Middlesex, Huron	John Gardner	50 King St., London, N6A 2P2	519-434-6811
Essex, Kent	Ed Tomecek	College of Agricultural Technology Ridgetown, N0P 2C0	519-674-5456
Essex, Kent	Leslie Huffman	Research Station, Harrow, N0R 1G0	519-738-2251
Marketing	Bob Cobbledick	Vineland Station, L0R 2E0	416-562-4142
Potatoes	Sam Squire	P.O. Box 370, Alliston, L0M 1A0	705-435-5521
Greenhouse Crops	Wayne Brown	Vineland Station, L0R 2E0	416-562-4141
Greenhouse Flowers	John Hughes	Dept. of Horticultural Science University of Guelph Guelph, N1G 2W1	519-824-4120 Ext. 8910
Turfgrass	Annette Anderson	Dept. of Horticultural Science University of Guelph Guelph, N1G 2W1	519-824-4120 Ext. 2597
Maple Syrup	John Butler	P.O. Box 340, Elmvale, L0L 1P0	705-322-2231
Nursery	Christoph Kessel	Unit 9, 35 Van Kirk Dr. Brampton, L7A 1A5	416-451-5474

PEST MANAGEMENT ADVISORS

Durham, Victoria, Peel (apples, pathology, fresh vegetables)	Andrea Clarke	234 King Street East Bowmanville, L1C 1P5	416-623-3348
Northumberland, Peterborough, Prince Edward (apples, processing vegetables)	Bernt Solymar	P.O. Box 340 Trenton, K8V 5R5	613-392-3527
North York (Bradford Marsh Area) (muck vegetable crops) (potatoes)	Jim Chaput Eugenia Banks	Muck Research Station R.R. #1, Kettleby, L0G 1J0	416-775-4261
Niagara Peninsula (apples, grapes) (peaches, tender and small fruit) (greenhouse floriculture)	Kevin Ker Gerald Walker Graeme Murphy	Vineland Station, N0R 2E0	416-562-4142
Haldimand-Norfolk, Brant (apples, pesticide alternatives) (cole crops)	Pam Fisher Janice Schooley	P.O. Box 587 Simcoe, N3Y 4N5	519-426-7120
Lambton, Middlesex, Huron (corn borer, cut worm, apples)		50 King Street London, N6A 2P2	519-434-6811
(muck vegetables, rutabagas) (field corn, cereals)	Richard Parry Tom Hartman	Centralia College of Agricultural Technology Huron Park, N0M 1Y0	519-228-6691
Essex, Kent (fruit trees) (greenhouse vegetables) (tomatoes, processing vegetables)	Todd Leuty Gillian Ferguson Janice Elmhirst	Research Station Harrow, N1R 1G0 College of Ag. Technology Ridgetown, N0P 2C0	519-738-2251 519-674-5456
Georgian Bay (apples, strawberries, asparagus)	Alison Watson	P.O. Box 69, Clarksburg, N0H 1J0	519-599-2042
Provincial Plant Pathologist	Craig Hunter	P.O. Box 587, Simcoe, N3Y 4N5	519-426-7120

ONTARIO MINISTRY OF THE ENVIRONMENT

PESTICIDES CONTROL FIELD OFFICES

Counties	Field Offices	Telephone
Bruce, Grey, Huron, Perth	B.T. Lobb Ont. Min. of Agr. & Food Bldg. 20 King St., Box 688 Clinton, Ontario N0M 1L0	519-482-3428
Essex, Kent, Lambton	H.E. Collins P.O. Box 726, 435 Grand Ave. W. Chatham, Ontario N7M 5L1	519-354-2150
Elgin, Middlesex, Oxford	D.C. Morrow/W. Lampman 985 Adelaide St. S. London, Ontario N6E 1V3	519-661-2200
Haldimand, Norfolk, Niagara, Hamilton, Wentworth Dufferin, Wellington, Waterloo, Brant	P. McCubbin/R. Miller Ontario Government Building 119 King St. W. Hamilton, Ontario L8N 3Z9	416-521-7640
Halton, Peel, York, Durham Toronto, Simcoe, Muskoka	A.G. Carpentier/H. Ploeg/ C. Zubovits 7 Overlea Blvd., 4th floor Toronto, Ontario M4H 1A8	416-424-3000 416-467-3029 416-467-3025
Peterborough, Victoria, Haliburton, Northumberland	A.G. Carpentier 139 George St. N. Peterborough, Ontario K9J 3G6	705-743-2972
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	D.A. Raddon/M. Ferguson 133 Dalton Ave., Box 820 Kingston, Ontario K7L 4X6	613-549-4000
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	R.P. Cameron 2435 Holly Lane Ottawa, Ontario K1V 7P2	613-521-3450
Manitoulin, Nipissing, Parry Sound, Sudbury, Cochrane, Timiskaming, Algoma	T. Spires/J. Negusanti/ K. McDonald 199 Larch Street Sudbury, Ontario P3E 5P9	705-675-4501
Kenora, Rainy River, Thunder Bay	G.R. Gammond Ontario Government Building 435 James St. S. Thunder Bay, "F", Ontario P7C 5G6	807-475-1215
Head Office	Pesticides Section 135 St. Clair Ave. W., Suite 100 Toronto, Ontario M4V 1P5	416-323-5095

PUBLICATIONS — The following publications are available from any of the Pesticide Control Field offices or from Agricultural & Industrial Chemicals Section, Suite 100, Ministry of the Environment, 135 St. Clair Ave. W., Toronto, Ontario M4V 1P5:

- Chemicals Safety Handbook
- Pesticides Act and Regulations

Chemical Storage Warning Sign
(attach to entrance door)

GENERAL INFORMATION ON PESTICIDE USAGE

READ THIS ENTIRE SECTION BEFORE USING ANY PESTICIDES

PRECAUTIONS WITH ALL PESTICIDES

General Precautions

1. Always read the label before opening pesticide containers, and follow all precautions and directions. Before starting keep a record of the common names of all pesticides handled and especially those listed as hazardous in this publication. This list should be known by members of your family in the event of an accident.
2. Use an anti-backflow device, to prevent back siphoning, when drawing water from wells, ponds, streams and other sources of water. Mix the pesticide at least 50 m from the water. Triple or pressure rinse the empty container and add rinse water to tank. Only mix enough solution to do the spray job. After loading and mixing wash down gloves and boots with clean water before removing.
3. Never smoke, chew tobacco or eat while handling or applying pesticides. Do not carry tobacco or food items in clothing worn while spraying. Change clothing and wash before eating.
4. When handling and mixing concentrates, rinsing empty containers or repairing leaks, a full set of protective clothing should be worn including waterproof cap, coveralls, impervious gloves and boots, and eye protection. If highly or extremely toxic pesticides are being used, a respirator should be worn. If very dusty formulations are being handled, a dust mask should be used. If volatiles or gases are being handled, a respirator must be worn. If these gases are highly dangerous or in an enclosed space a self-contained breathing apparatus may be needed.
5. During application, tractor cabs with charcoal filters give adequate protection against exposure. Impervious gloves, boots, coveralls and caps should be worn when tending to stoppages. When using air-blast and mist blowers and tractors without cabs, waterproof suits including caps and impervious gloves and boots should be worn. When applying fumigants in the field, a respirator should be available for problems with equipment or if the fumigant is not adequately sealed in the soil and escapes.
6. When the spray operation is complete, rinse gloves and boots before removal. All clothes should be double laundered separately from normal laundry. Underwear should be changed daily. It is wise to change twice a day, at lunch and then at the end of the day, wearing clean clothes each time. Take a bath or shower after spraying to remove pesticide deposits on the skin. Avoid handling anything in the home before bathing.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing including underclothes immediately, and wash contaminated skin thoroughly with soap and water. Wash gloves, boots, and respirator before and after removal. Presoak clothes and double launder immediately. If the spill was serious, place the clothes in a plastic bag and dispose in a safe manner.
2. If clothing becomes wet with a pesticide, during spraying, remove it immediately, wash and put on freshly laundered clothes.
3. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. Take the list of common-name chemicals with you to the hospital (see Emergency Procedures for Pesticide Poisoning on the back cover).
4. Clean up any pesticide spills immediately. In the case of minor spills, use dry soil or other absorbent material to remove excess liquid and sweep up powders and granulars. Contaminated soil and sweepings should be spread over a larger area or bare soil to facilitate rapid degradation. Make sure you are adequately protected when cleaning up the spill.

   In the case of a major pesticide "spill" the Ministry of the Environment, Spills Action Centre, 5th Floor, 7 Overlea Blvd., Toronto, Ontario, M4H 1A8, telephone (416) 965-9619 or 1-800-268-6060 must be notified.
5. If a well becomes contaminated, follow clean-up instructions in OMAF Factsheet, *Pesticide Contamination of Farm Water Supplies*, Agdex 607.

EMERGENCY PROCEDURES FOR PESTICIDE POISONING FIRST-AID INFORMATION
(See Back Cover)

RELATIVE TOXICITY TO APPLICATOR

Definitions

Lethal Dose 50% (LD_{50}) The dose which when administered will kill 50% of the test animals within a stated period of time (i.e., 1-6 days).

Acute Toxicity Immediate adverse effects from a single or short period exposure to a substance, either by the oral, dermal or inhalation route.

Chronic Toxicity Adverse effects resulting from repeated exposure to a substance over an extended period of time.

High Acute Toxicity

These pesticides are extremely dangerous if handled carelessly. The acute oral LD_{50} is less than 50 mg/kg of body weight and the acute dermal LD_{50} less than 200 mg/kg body weight. These pesticides can be fatal by swallowing less than 0.1 to 3 mL (one drop to half a teaspoonful). These pesticides carry the skull and crossbones in a stop sign. In using these products a respirator and eye protection is required along with all other protective clothing:

azinphos-methyl (Guthion, APM)
diphacinone (Ramik Brown, Ramik Green)
endosulfan (Thiodan)
methomyl (Lannate)
paraquat (Gramoxone)
zinc phosphide

Moderate Acute Toxicity

These pesticides are dangerous if handled carelessly. The acute oral LD_{50} is 50 to 500 mg/kg of body weight and the acute dermal LD_{50} is 200 to 2000 mg/kg body weight. These pesticides can be fatal by swallowing 3 to 30 mL (half a teaspoonful to 2 tablespoonsful). These pesticides carry the skull and crossbones on a stop sign. In using these products a respirator and eye protection along with all other protective clothing are recommended when handling the concentrate:

1,3-D (Telone II, Telone C-17, Vorlex plus, Vorlex plus CP)
chlorpyrifos (Dursban)
diazinon (Basudin)
dimethoate (Cygon)
phosmet (Imidan)
pirimicarb (Pirimor)

Low Acute Toxicity

These pesticides are not fatal unless deliberately ingested in amounts of over 30 mL (1 oz). The acute oral LD_{50} is greater than 500 mg/kg body weight and the acute dermal LD_{50} greater than 2000 mg/kg body weight. Pesticides listed in this publication and not appearing in the lists in this section have low acute toxicities and should be handled with caution. Protective clothing is required. Respirators are advised when used in confined spaces. Eye protection is advisable and other protective clothing should also be worn.

Chronic Toxicity

It is not possible to assess chronic toxicity of a pesticide in the same way as an LD_{50} is used to determine acute toxicity. Instead, a number of tests are performed on animals which help predict whether a pesticide will cause a number of possible long-term effects. Animals are examined for a wide variety of toxic effects such as the production of tumors or abnormalities. Protective clothing and equipment is advisable to reduce exposure and the risk of chronic effects:

1,3-D (Telone II, Telone C-17, Vorlex plus, Vorlex plus CP)

For further information on pesticide toxicity see Table 2 on page 7.

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of inactivating the serum and the red blood cholinesterase levels. If the activity of cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms.

For those working outdoors and applying these groups of pesticides, it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value the tests should begin prior to using these pesticides and not after applications have commenced, since the normal level per individual can vary considerably, making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are:

azinphos-methyl (Guthion, APM)
carbaryl (Sevin)
chlorpyrifos (Dursban)
diazinon (Basudin)
dimethoate (Cygon)
methomyl (Lannate)
pirimicarb (Pirimor)

PROTECTIVE CLOTHING WHEN USING PESTICIDES OUTDOORS

1. **Why Use Personal Protection?** Pesticide formulations vary in their toxicity from slightly to extremely poisonous. Once the pesticide is removed from the container, exposure occurs. The toxicity of the pesticide and the exposure to the user creates a hazard which varies from spray operation to spray operation. Both can be reduced, toxicity by dilution and exposure by protective clothing. The action taken by the applicator to reduce the hazard of a spray operation lessens the risk of poisoning. While the hazard of a situation remains, the risk can be changed by the care and protection followed by the applicator. Wearing the required protective clothing reduces the risk to a minimum.
2. **Risk of each stage in pesticide operation.**
   (1) Handling and mixing concentrate — very high risk
   (2) Rinsing empty containers — high risk
   (3) Application outdoors — low to high risk
   (4) Application indoors — medium to very high risk
   (5) Clean up, equipment rinsing — medium to high risk
   (6) Reentry into treated area up to 48 hours — low to medium risk
3. **Exposure can be by way of skin, eyes, mouth, or nose.** Approximately 80-85% of the exposure in most spray operations occurs during mixing and loading of the concentrate. Field application usually accounts for 15-20% of the exposure. Skin exposure is usually 90 to 100% of the total exposure and around 70% of this is by way of the hands and forearms and 30% involves the rest of the body. Inhalation (nose and mouth) exposure is normally 0.1% but rises to 5-10% with the use of mist blowers and air blast sprayers.
4. **To reduce skin (dermal) exposure** wear impervious gloves (neoprene, rubber, etc.) and waterproof boots, along with coveralls, apron or spray suits and waterproof cap. Coveralls can be reusable or disposable. Reusable coveralls are normally cotton or polyester and should be tightly woven. Polyester is more easily penetrated than cotton. Disposable coveralls are polyethylene and can be laundered several times. Spray suits should be used in highly hazardous conditions as with mist blowers and air blast machines. Eye protection should be practised with all pesticide concentrates.
5. **Respirators are recommended** when handling pesticides with labels carrying the warning stop sign with skull and crossbones that call for respiratory protection. Respirators should be used when spraying all pesticides rated as having a high toxicity or applying any liquified gas. Respirators are available as air purifiers or self-contained units. Respirators come in a wide range of shapes and sizes; consult the label and your nearest safety supply company for advice.
6. **Protective clothing deteriorates and pesticides eventually break through** to the skin. It is wise to check and replace clothing that is worn out, cracked, torn or severely abraised. All protective clothing should be washed after each use, including respirator, boots, gloves and spray suits. After use, decontaminate and dry before storing in a clean and dry place.

7. **Consult the safety supply house** of your choice for appropriate guidance and selection of your protective clothing (see Table 1).

TABLE 1. SAFETY SUPPLY COMPANIES IN ONTARIO PROVIDING PROTECTIVE CLOTHING AND/OR RESPIRATORY DEVICES FOR OUTDOOR PROTECTION AGAINST CERTAIN PESTICIDES

Respiratory Devices Manufactured By	Available From	Telephone
American Optical	AOCO Limited, Subsidiary of American Optical Corporation, 80 Centurian Drive, Markham L3Y 5Y5 Branches: Hamilton and Belleville	(416) 479-4545
H.S. Cover (York)	Levitt-Safety Ltd., 33 Laird Drive, Toronto M4G 3S9 Branches: Kitchener, London, Ottawa, Sarnia, Stoney Creek, Sudbury and Thunder Bay	(416) 425-8700
Kasco Helmets	The St. George Co., R.R. #1, St. George N0E 1N0	(519) 442-2046
Mine Safety Appliances	MSA Canada Inc., 148 Norfinch Drive, North York M3N 1X8	(416) 667-9400
3M Canada Inc. Occupational & Environmental Safety Div.	A wide range of distributors P.O. Box 5757, London, Ontario N6A 4T1	(519) 451-2500
North	Siebe-North Inc., 26 Dansk Court, Rexdale M9W 5V8	(416) 675-2810
Racal Airstream	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill (Toronto) L4B 1E7 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor	(416) 222-4111 (416) 222-2111
Safety House	Safety House of Canada Ltd. 1275 Castlefield Ave., Toronto M6B 1G4 Branches: Kitchener, London, Orillia, Ottawa, St. Catharines and Stoney Creek	(416) 789-0631
Scott	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill (Toronto) L4B 1E7 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor	(416) 222-4111 (416) 222-2111
Survivair	Levitt-Safety Ltd., 33 Laird Drive, Toronto M4G 3S9 Branches: Kitchener, London, Ottawa, St. Catharines, Sarnia, Stoney Creek, Sudbury and Thunder Bay	(416) 425-8700
Willson	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill (Toronto) L4B 1E7 Branches: Hamilton, Kingston, Kitchener, London, St. Catharines, Sarnia, South Porcupine, Thunder Bay and Windsor	(416) 222-4111 (416) 222-2111

Many of the companies listed above have dealer outlets in addition to branch outlets. For details of dealer outlets, contact the supply company of your choice.

REENTRY TO TREATED AREAS

Pesticide poisoning may occur when workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors.

The pesticides listed below are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides (e.g., parathion), the label carries a warning regarding working in treated crops. **Follow these recommendations.** Where no label warnings are provided, the following minimum intervals are recommended:

24 Hours	**48 Hours**
Lannate (methomyl)	APM (azinphos-methyl) Guthion (azinphos-methyl)

PESTICIDE STORAGE

General Storage:

The Ontario Pesticides Act and Regulation 751 require that all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans, and feed for animals. Herbicides should be stored separately from other pesticides to avoid possible contamination. Storage area should be adequately ventilated.

Special Storage:

1. Schedule 1, 2 and 5 pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words **"Chemical Storage Warning – Authorized Persons Only"** in block capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide, or with his permission.
2. **Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers.** Also see OMAF Factsheet, *Farm Storage of Pesticides*, Agdex 607.
3. In areas where flooding has been a frequent occurrence, fertilizers and pesticides must be stored above the known high water mark to avoid contamination of the flood waters. Contamination of water by these chemicals can and has led to serious health problems affecting humans, domestic animals as well as fish and wildlife.

DISPOSAL OF PESTICIDE CONTAINERS AND CONTAMINATED MATERIAL

1. Pesticide containers and any paper or other material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke, and that the smoke is not direct toward buildings, highways, roads, or outdoor public areas.
2. Unrinsed containers can contain as much as 3% of the original formulation. If this amount of toxic pesticide is discarded with the drum, it could be dangerous to other people handling it, or to the environment (for example, your water supply). Failure to rinse is also wasteful; why not use that 3% for the purpose for which it was purchased, to control the pest!

Rinse all empty metal or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic drum, and to rinse the residue left in the container directly into the spray tank. This procedure takes less than a minute. The rinsed containers may be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table.

TABLE 2. CLASSIFICATION OF CHEMICALS USED TO PROTECT ORNAMENTALS

Trade name(s) given in this publication		**Common name**	**LD_{50} (mg a.i./kg)****	**Chemical Family****
Agri-Mycin 17	*(3)	streptomycin sulphate		
Ambush	(3)	permethrin	4000 +	Syn. Pyr.
APM, Guthion	(5)	azinphos-methyl	20	OP
Basamid	(2)	dazomet	640	Thia
Belmark	(3)	fenvalerate	451	Syn. Pyr.
Benlate,	(3)	benomyl	1000 +	Ben
Bordeaux		spray tank mixture of copper sulphate, hydrated lime and water		
Botran	(3)	dichloran	10,000 +	Dicarb
Captan, Orthocide C, Stauffer C	(2)	captan	9000	Ph.
Cygon	(2)	dimethoate	215	OP
Cyprex	(3)	dodine	1000	AN
Daconil 2787	(3)	chlorothalonil	10,000+	Arom.
Disyston	(2)	disulfoton	5	OP
Diazinon, Basudin	(2)	diazinon	300	OP
Dursban, Lorsban	(3)	chlorpyrifos	135	OP
Dygall	(2)	*Agrobacterium radiobactor*	non-toxic	Biological
Dyrene	(3)	anilazine	5000+	Arom.
Dylox, Danex	(3)	trichlorfon	560	OP
Easout	(3)	thiophanate-methyl	7500	Ben
Ferbam, Karbam Black	(3)	ferbam	17,000+	Dithio
Fixed copper	(3)	fixed copper		Copper
Funginex	(3)	triforine	16,000+	EBI

Continued on page 8.

TABLE 2: CLASSIFICATION OF CHEMICALS USED TO PROTECT ORNAMENTALS (continued)

Trade name(s) given in this publication		Common name	LD_{50} (mg a.i./kg)**	Chemical Family**
Guthion, APM	(5)	azinphos-methyl	20	OP
Hinder	(6)	ammonium soaps of higher fatty acids		X
Imidan	(3)	phosmet	300	OP
Kelthane	(2)	dicofol	684	OC
Lannate	(2)	methomyl	17	Carbamate
Lindane	(2)	lindane	88	OC
Malathion	(3)	malathion	1400	OP
Manzate 200, Dithane M-45	(3)	mancozeb	6750	Dithio
Meltatox	(3)	dodemorph-acetate	4180	Morph
Metaldehyde bait	(3)	metaldehyde	630	Metaldehyde
Metasystox-R	(2)	oxydemeton-methyl	75	OP
Methoxychlor, Moxy	(3)	methoxychlor	6000	OC
Morestan	(3)	chinomethionat	2500	Carbonate
Orthene	(3)	acephate	866	OP
Pentac	(3)	dienochlor	3160	OC
Phaltan, Folpan	(3)	folpet	10,000	Ph
Pirimor	(2)	pirimicarb	147	Carbamate
Polyram	(3)	metiram	10,000+	Dithio
Ramik Brown	(6)	diphacinone		r
Rovral	(3)	iprodione	3500	Dicarb
Sevin	(3)	carbaryl	560	Carbamate
Sumithion	(3)	fenitrothion	250	OP
Bartlett, Chipman, Niagara	(3)	sulphur		Sulphur
Thiodan, Thionex	(2)	endosulfan	110	OC
Thiram	(3)	thiram	780	Dithio
Thuricide, Dipel	(3)	*Bacillus thuringiensis*	non-toxic	Biological
Vendex	(3)	fenbutatin oxide	2631	Organotin
Zineb, Dithane Z-78	(3)	zineb	5000+	Dithio

** The numbers within the brackets ( ) identify the Schedules in which the BRAND NAME products listed in this Table are classified under the Pesticides Act.*

Explanation of Schedules

Schedule 1 Restricted Use permit only.
Schedule 2 Restricted to agriculturalists, licensed exterminators and registered custom sprayers.
Schedule 3 May be available for "Domestic" purposes if so registered.
Schedule 4 "Domestic" products only.
Schedule 5 Limited to application on agricultural land.
Schedule 6 Similar to schedule 4 but may be registered for agricultural/commercial use.

For further information on the regulatory aspects of the classification, please contact the Ministry of Environment office nearest you.

*** The relative toxicity of a pesticide may be referred to as its LD_{50}. This is the amount of the active ingredient (a.i.) of the chemical in milligrams used per kilogram of test animals (usually female rats) that kills 50% of the test animals. This is commonly measured as the Acute Oral LD_{50} (above) which refers to the chemicals ingested through the mouth or nose. Dermal LD_{50} or skin penetration figures are available. The higher the LD_{50} value, the less toxic the product is to humans.*

**** Chemical families*

AN — aliphatic nitrogenous compound
Arom — aromatic hydrocarbon
Ben — benzimidazole
Dicarb — dicarboximide
Dinitro — dinitrophenol
Dithio — dithiocarbamate
EBI — ergosterol biosynthesis inhibitor
Morph — morphactin
Ph — phthalimide
OC — organochlorine
OP — organophosphorous
Org — organatin
OX — oxithin
r — rodenticide
Syn. Pyr. — Synthetic pyrethroid
Thia — thiadiazole
X — repellent

Additional information on protective equipment may be found in *Personal Protective Equipment for Pesticide Users*, available at offices of the Pesticides Control Service, your pesticide dealer, and offices of the Ontario Ministry of Agriculture and Food.

PROTECTIVE CLOTHING WHEN USING PESTICIDES IN GREENHOUSES AND OTHER ENCLOSED AREAS

Respiratory Protection — Available Devices

Air-Purifying Devices — Canister Gas Masks

Canister gas masks have been used effectively for many years by greenhouse applicators for respiratory protection against certain gases, vapors and particulate matter which otherwise might be harmful to life or health.

From a practical standpoint, canister gas masks are generally suitable for ventilated areas not subject to rapid change, but should never be used in confined spaces where oxygen deficiency and high gas concentrations may occur.

Working Conditions

High Concentrations

(a) Use only a self-contained breathing apparatus (e.g., Scott's, Air Pak)

(b) High concentration of toxic gases, vapors or particulate matter can be produced when dispensing extremely or highly toxic pesticides such as parathion, nicotine and naled (Dibrom):

1. through fogging machines,
2. by means of smoke bombs,
3. as spray applications.

In such instances self-contained breathing apparatus is recommended.

Low Concentrations

Canister gas masks may be used when the ambient air contains low concentrations of toxic gases, vapors or particulate matter derived from soil-drench, granular, dust, or foliar spray applications. Pesticides applied in such manner are usually of moderate to low toxicity. The exceptions include aldicarb (Temik 10G) and fensulfothion (Dasanit 15G) but the wearing of canister gas masks provides protection.

Contact your safety supply company for the proper canister selection.

Other Clothing

When measuring, mixing and applying pesticides, wear neoprene or rubber gloves, rubber boots, a protective apron or coveralls, hat, and protective eyeshields or a full-face mask.

METHYL BROMIDE AND INSECTICIDE SMOKES

A permit issued by the Ontario Ministry of the Environment is necessary to use methyl bromide (MC-2 and MB-C_2). To apply for a permit contact:

Pesticide Section
Hazardous Contaminants Coordination Branch
Ontario Ministry of the Environment
135 St. Clair Avenue West
Toronto, Ontario M4V 1P5
Telephone: (416) 323-5095

When using methyl bromide or insecticide smoke generators, suitable protective clothing must be worn. After treatment, the greenhouse must be barricaded and warning signs posted. In general, smokes are especially useful for small greenhouses of 930 m^2 or less. Smoke applications are not satisfactory for spot treatment.

PEST RESISTANCE TO INSECTICIDES, FUNGICIDES AND MITICIDES

Many of the pesticides recommended have a very specific mechanism of action, that is, they act on a single system or site in the organism. These materials should not be used continuously and repeatedly in a season-long program, since this will increase the chances of the development of pest resistance. Examples of these types of compounds are Benlate, Easout, Cyprex, Lannate, and Ambush.

Pests are said to be resistant when they are able to survive exposure to rates of pesticides that previously controlled them. Generally, resistance to a pesticide develops after repeated exposure to a specific chemical. Resistance occurs because a few naturally occurring resistant individual pests survive after each spray, while the susceptible portion of the population is killed. These resistant survivors multiply and gradually replace the susceptible ones. Eventually only a resistant population remains, which cannot be controlled by the pesticide.

The development of resistance to pesticides can occur very quickly. The same chemical should not be used repeatedly without being alternated with a different chemical or without being used in combination with other chemicals having a different mode of action. This practice will reduce the likelihood of resistance developing in the pest population.

It should be noted that several pesticides may act similarly. For example, Benlate and Easout act on the same site and if resistance develops to one, it is likely to apply also to the other. This is called cross-resistance. Thus, alternating these compounds will not be useful. Rather, they should be alternated with fungicides with different modes of action, as for example, captan or maneb.

PESTICIDE INJURY TO CROPS

Although insecticides and fungicides have been selected and formulated to avoid plant injury, damage can still occur under some conditions. In addition to the precautions mentioned in this publication, there are a number of others which should be observed:

1. Apply sprays when the drying condition is fast. Some chemicals break down to components which are injurious to plant tissues if they are permitted to stay wet.
2. Apply sprays when the temperature is below 27°C. The spray deposits serve as a lens and concentrate the heat on the plant tissues.
3. Be particularly careful when plants have been under growth stress such as prolonged periods of drought, excessive cloud cover, extremely low or high temperatures.
4. Apply sprays soon after mixing. Undesired chemical change may take place with some chemicals if the sprays remain in the tank for prolonged lengths of time, for example, overnight. In other cases, the chemicals may settle out and clog the lines.

REDUCE BEE POISONING

Bees are essential for the pollination of most trees and small fruits. Insecticides, many of which kill bees, are required for insect control. With careful management, you can protect the bees by following these suggestions:

1. **Do not apply insecticides while tree fruits are in bloom. The "Bees Act" makes it an offence to do so in Ontario.**
2. Time of treatment is important. In general, daytime treatments, when bees are foraging in the field, are most hazardous. Insecticide applications in the very early morning or evening are safest.
3. If there is a risk of honey bee poisoning, try to choose an insecticide that is not highly toxic to the bees.
4. Honey bees frequently are poisoned by visiting cover crops, such as dandelions or clovers, that are in bloom in adjacent areas. Clipping or mowing down such crops prior to spraying will help safeguard the bees.

Extremely Toxic to Bees — Sevin

This insecticide has caused more loss (confirmed cases of poisoning) to bees than any of the other materials listed below.

The following groups (chemicals used with fruit crops) show the relative toxicity of pesticides to honey bees as determined by laboratory and field tests in California.

Pesticides Highly Toxic to Bees

Severe losses may be expected if the following materials are used when bees are present at treatment time or within a few days thereafter:

Ambush	diazinon	Imidan
APM	Elgetol	malathion
Cygon	Guthion	Sevin

Pesticides Moderately Toxic to Bees

These can be used around bees if dosage, timing, and method of application are correct, but should not be applied directly on bees, in the field or at the colonies:

Lannate	Pirimor	Thiodan

Pesticides Relatively Non-Toxic to Bees

Benlate	ethion	Phaltan
Bordeaux	ferbam	Polyram
captan	Funginex	Rotenone
Cyprex	Kelthane	Rovral
Dithane	Manzate	sulfur
Dyrene	methoxychlor	zineb
Easout		

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby or reduce the amount of material in the target area as to be ineffective. Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by:

1. correctly calibrating and maintaining spray equipment,
2. correctly operating the equipment,
3. being aware of the toxicity of the pesticide in use,
4. being aware of the weather conditions.

For more information consult OMAF Factsheet, *Pesticide Drift*, Agdex 607 or Canadex 607, *Pesticides: Effects of Drift and Droplet Size.*

AERIAL APPLICATION

Aerial applicators must be licenced by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of the Pesticides Act 1973 for the application of Schedule 1 and 5 pesticides and Schedule 2 hormone-type herbicides. The area will be inspected by Ministry personnel to ensure safety of application.

It is an offense under the Federal Pest Control Product Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honey bees, for example, Sevin (carbaryl).

Applications should not be made if the wind is blowing. Some drift occurs even on the stillest day and to keep it to a minimum, apply pesticides in the evening or early morning.

Be sure that the product to be used is specified, along with rate of application, in the contract.

WEED CONTROL

For complete weed control recommendations including comprehensive information on chemicals, safety precautions and calibration and care of sprayers, use Ontario Ministry of Agriculture and Food Publication 75, *Guide to Weed Control.*

Unless otherwise mentioned, the recommendations are intended to apply only to herbicides used with field-grown crops. The use of certain herbicides in greenhouses or cold frames can injure the crop.

Chemical weed control should never be a substitute for good cultural practices. Reduce the spread or increase of weed seeds by cutting or disking weeds before they go to seed. Concentrate on the eradication of persistent perennial weeds by cultural practices. Thorough working of the land prior to seeding or planting will kill many small weeds that have just germinated. Careful shallow cultivation is best. The modern grower should use chemical weed killers wherever practical as a supplement to good cultural practices.

It is very important to apply the correct dosage when using these chemicals. Herbicides can cause severe injury to the crop if more than the recommended rate is used. **Do not experiment** with chemicals or mixtures which are not recommended.

Herbicide Use Precautions

Spray drift can damage or destroy susceptible crops for a great distance from the sprayer. Use extreme caution when applying hormone-like herbicides (2,4-D, MCPA, etc.) near susceptible plants or crops. These herbicides should only be applied when it is calm (either early morning or late evening) or when a very light wind is blowing away from any susceptible plants. Use low pressures whenever possible – only enough pressure required (200-250 kPa) to get uniform distribution. High pressures produce many small droplets which drift. **Do not use the same sprayer for applying 2,4-D and similar herbicides as you use to apply insecticides and fungicides.** Drain and wash out the sprayer immediately after use. Do not empty herbicide mixtures or wash water into drainage ditches, streams or ponds or places where the herbicides can be washed into them. Do not mix different herbicides, or herbicides with other pesticides or foliar fertilizers, unless recommended by competent authorities.

MOUSE CONTROL

In September look for signs of mice: fresh grass clippings in runways, droppings, and tunnels. Probably the best bait at present is zinc phosphide-treated cracked corn.

As a supplement to poisoning, remove straw, trash, sod, etc., from around the base of the trees in the fall for at least 60 cm from the trunk.

Baits available

1. Waxed Zinc Phosphide bait - 5.5-11 kg per hectare depending on the severity of infestation. When further mice activity is detected and rain is not expected, repeat the treatment.
2. Ramik Brown - 22 kg per hectare in two applications of 11 kg each. Applications can be made 20-40 days apart.
3. Rozol Paraffinized Pellets (0.005% chlorophacinose). Apply at rate of 11 kg per hectare.

Precautions in Handling Poison Baits

All containers used for poison bait should be marked POISON and stored away from children, irresponsible persons, pets and livestock. Baits containing zinc phosphide should not be kept in a building where there are people or animals.

Equipment for mixing and applying poison bait should be kept for that purpose alone.

Wear rubber or other gloves for hazardous insecticides, and wash after handling poison baits. Do not inhale zinc phosphide dust or fumes.

These baits are recommended for use in commercial nursery plantings only.

Dogs that are enthusiastic mousers should be kept out of the nursery for two or three days to prevent them from catching a large number of dying mice.

Tree Guards

Set wire tree guards of 6 mm mesh galvanized wire around the trunk. Set them about 8 cm deep in a mound of fine crushed stone or sharp cinders. Check the guards each fall to see that they are mouse-tight and free of trash. Tree guards are especially valuable in protecting young trees for a long period of time.

A number of other materials are suitable for mouse guards. A number of other commercial tree guards are also available. Do not use tar paper because it may damage the bark.

Regular inspection should be carried out throughout the winter to see if any injury has occurred. Mice work just below the surface of the snow or litter.

RABBIT CONTROL

Repellents

A number of rabbit repellents are available. Some contain thiram (Skoot) or ammonium soaps of higher fatty acids (Hinder). Consult the directions on the container label. Be sure to treat the tree as high as rabbits can reach when standing on deep snow. The repellents may be applied with a small knapsack sprayer or painted on with a brush.

Shooting

Shooting rabbits is an excellent means of keeping the population down. However, it must be done regularly throughout the year because other rabbits soon move into the area. Shooting alone cannot be depended upon to provide adequate control.

Wrapping Young Trees

Wrap sacking about the top and the trunk, above the mouse guard, to protect young trees from rabbits. Tie the wrapped tree securely to a strong stake or steel fence post to prevent snow and ice breaking the tree over. Mouse guards generally do not give protection against rabbits when snow is deep.

DEER CONTROL

Some repellents used to control rabbits may also help to reduce deer browsing. Hanging bars of a highly fragrant soap around the perimeter of the field on the windward side, may be helpful in discouraging deer. The soap should be hung with the wrapper intact except at the bottom end where the soap is exposed.

For additional information on rodent control, refer to OMAF Factsheet, *Rodent and Deer Control in Orchards,* Agdex 210/681.

SOIL MANAGEMENT AND FERTILIZER USE

GENERAL INFORMATION

Soil Sampling and Testing

The addition of fertilizer to nursery stock and landscape plants should be based on the plants' nutrient requirements. Chemical soil tests are a way of evaluating the level and availability of soil nutrients, establishing the need for and amount of fertilizer to be added to attain optimum growth. Soil samples are easily taken and should be a continuing part of a grower's cultural program.

For field soils, samples are best taken to a depth of 20 cm, using a soil probe or spade, from a minimum of 20 locations per hectare. Mix the soil thoroughly in a clean container and select a cupful for analysis. If the area to be tested is known to be of varying soil types or has received varying levels of fertilizer or organic matter, they should be tested separately (i.e. samples from sandy and loamy soil or from areas of poor drainage or where the addition of manure or sewage sludge has occurred).

Samples from container-grown stock should be taken with a small diameter sampling probe from at least 10 pots. Always sample prior to adding a dry surface fertilizer (granular or pellet) and avoid sampling immediately after liquid feeding. If water-soluble fertilizer is being applied continuously, samples may be taken at any time. Where a dry fertilizer residue remains on part of the surface of the container mix, insert the probe avoiding the residue. The best way to obtain a sample is to remove the pot and take a core through the medium midway between top and bottom.

Soil samples from the field and container potting mixes should be analyzed by a commercial laboratory. Several laboratories have been accredited by OMAF. These laboratories must meet and maintain established levels of proficiency on the basic tests to remain accredited. All analyses are on a fee for service basis. For further information on the accredited laboratories, the tests performed and fee schedules, contact any OMAF field office. Each office has generic submission forms and sample containers. OMAF staff will continue to provide assistance on technical interpretation of test results, if indicated on the submission form, at no charge to the grower.

TABLE 3. AVERAGE FOLIAR NUTRIENT CONTENT OF HEALTHY NURSERY STOCK

	N %	P %	K %	Ca %	Mg %	Mn ppm	Cu ppm	Zn ppm	B ppm	Fe ppm
Field grown										
broadleaf evergreens	2.3	.27	1.1	2.5	.3	25	5	27	42	120
conifers	1.7	.24	1.0	1.0	.2	88	6	31	35	87
deciduous trees and shrubs	2.8	.25	1.7	2.4	.4	62	7	25	58	133
Container grown										
conifers and broadleaf evergreens	2.5	.4	1.4	2.0	.3	52	5	24	48	127

Tissue Testing - Foliar Analysis

At the present time foliar analysis is used to diagnose suspected nutrient disorders in field and container grown nursery stock. Samples should be taken in July or August. From deciduous or broadleaf evergreen trees and shrubs select approximately 50 fully expanded leaves midway along a shoot of the current season. From conifers select 10-15 ten cm long shoots of current season growth, removing the needles and discarding the twigs of pines, spruces and firs. If foliage is dirty, it should be rinsed in clean water. A sample of healthy leaves from the same area should also be submitted at the same time for comparison.

Samples should be air-dried or shipped in paper bags to avoid moulding. Check with OMAF field offices for laboratories accredited for foliar analysis. Please contact the laboratory or nursery specialist regarding the analysis fee.

Table 3 provides a guide to normal foliar nutrient concentrations of nursery stock. Values for established landscape stock are usually somewhat lower.

Soil pH

Soil pH is a measure of acidity or alkalinity on a scale from 0 to 14. The middle of the scale, 7, is neutral, with values below 7 being increasingly more acid and values above 7 increasingly more alkaline. Most Ontario soils are between 5.0 and 8.5. As soil acidity increases, the solubility of elements such as iron and manganese also increases. Many other elements are less available below pH 6.0.

Most nursery stock grows well between pH 5.0 and 7.2. Plants such as red maple, pine, oak, tuliptree and euonymus may exhibit iron and/or manganese chlorosis if the pH is above 7.0. For ericaceous plants and conifer seedbeds, the pH should be below 6.5.

Buffer pH

Different soils with any one soil pH value will require different amounts of lime to bring the pH to a particular desired level, depending chiefly on the clay and organic matter content of each soil. The soil pH is used to determine which soils need to be limed but a separate soil test, the buffer pH, is run to determine the amount of lime required. For soils needing lime, based on soil and buffer pH, use the Lime Requirement Table 4 to determine the amount of lime required to reach different "target" soil pH values required.

TABLE 4. LIME REQUIREMENTS TO CORRECT SOIL ACIDITY BASED ON SOIL pH AND SOIL BUFFER pH

Buffer pH	Target Soil pH = 6.5 Lime if soil pH below 6.1	Target Soil pH = 6.0 Lime if soil pH below 5.6
	Ground limestone required — t/ha (Based on an Agricultural Index of 75)	
7.0	2	0
6.5	3	2
6.0	9	6
5.5	17	12
5.0	20	20

Limestone Quality

Calcitic limestone consists largely of calcium carbonate. Dolomitic limestone is a mixture of calcium and magnesium carbonates. Dolomitic limestone should be used on soils with a magnesium soil test of 100 ppm or less as it is an excellent inexpensive source of magnesium for acid soils. On soils with magnesium tests greater than 100 ppm, either calcitic or dolomitic limestone may be used.

Two main factors affect the value of limestone for soil application. The amount of acid a given quantity of limestone will neutralize when it is totally dissolved is called the "neutralizing value". It is expressed as a percentage of the neutralizing value of pure calcium carbonate. A limestone which will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. Generally, the higher the calcium and magnesium content of a limestone, the higher its neutralizing value.

The second factor which affects the value of limestone as a neutralizer of acidity is the particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone; it neutralizes acidity much more slowly than a finely ground limestone.

Raising pH

Lime is used to raise pH. General lime application rates for most crops, based on soil pH and buffer pH, are listed in table 4.

Lowering pH

Sulfur can be used to lower pH. Other acidifying materials such as aluminum sulfate or iron sulfate are less effective than sulfur, are potentially phytotoxic and their use if often limited to pot culture. The use of sulfur is not practical for large areas. Table 5 is based on rates of application per 100 square metres. In order to keep the pH at or near a desired level, the use of sulfur must be continued each year or every other year. A soil test for pH taken in the spring should be the basis upon which to continue the use of sulfur. It is not feasible to acidify soils with sulfur when the pH is above 7. If the pH must be lowered on small areas, the soil should be replaced or amended with large quantities of acid peat. When using organic materials be sure to test the pH since leaf mold, compost and some peat may be basic rather than acidic.

The long-term use of fertilizer materials such as ammonium sulfate, urea, potassium sulfate and mono-ammonium phosphate will cause a gradual reduction of soil pH. Anhydrous ammonia will cause a temporary but marked increase in pH when first applied. Super phosphate, ammonium nitrate and muriate of potash will have little or no effect on pH. Excessive use of certain nitrogen fertilizers may, in time, require the addition of lime to light, sandy soils.

TABLE 5. SOIL ACIDIFICATION TO pH 5.0 WITH SULFUR

Initial pH	Soil Type	
	Sand	Loam
7.0	7.4*	22.6
6.5	6.0	17.5
6.0	4.0	12.0
5.5	2.0	6.0

**kg of elemental sulfur per 100 m² for 2 successive years.*

TABLE 6. FIELD SOIL CONDUCTIVITY READING INTERPRETATION

Conductivity "salt" reading millisiemens/cm	Rating	Plant Response
0-0.25	L	Suitable for most plants if recommended amounts of fertilizer are used.
0.26-0.45	M	Suitable for most plants if recommended amounts of fertilizer are used.
0.46-0.70	H	May reduce emergence and cause slight to severe damage to salt sensitive plants.
0.71-1.00	E	May prevent emergence and cause slight to severe damage to most plants.
1.00	E	Expected to cause severe damage to most plants.

For greenhouse soils the OMAF soil test uses a larger soil sample and measures conductivity on a saturation extract. For greenhouse crops using that method, conductivity readings up to 3.5 millisiemens/cm are acceptable (see Table 13, Soil Nutrient Levels for most container crops, page 18).

Soluble Salts in Soil

High concentrations of water-soluble salts in soils can prevent or delay germination of seeds and can kill newly transplanted plants or seriously retard the growth of either newly transplanted or established plants.

Ontario soils are naturally low in soluble salts. Soluble salts therefore rarely cause a problem in crop production and are not routinely measured in soil tests.

Soluble salts in soils can result from excessive applications of fertilizers, runoff of salts applied to roads and chemical spills. A given amount of salt in a soil provides a higher soil water salt concentration if the amount of water is small. Soluble salts also interfere with the uptake of water by plants. For these reasons, plant growth is most affected by soluble salts in periods of low moisture supply.

Soluble salts can be measured readily in the laboratory by measuring the electrical conductivity of a soil water slurry. The higher the concentration of water-soluble salts, the

higher the conductivity. Table 6 provides an interpretation of soil conductivity readings in Ontario field soils in a 2:1 water:soil paste mixture, the procedure used by OMAF accredited soil testing laboratories.

Organic Amendments to Soil

Soil organic matter plays an important role in maintaining good soil structure, aeration and penetration of water. Soil structure and aeration is important for root development and plant growth. Rapid penetration of water minimizes erosion. Organic matter broken down and/or lost through clean cultivation practices should be replaced by the addition of organic amendments.

Manure is an important organic matter amendment that contains considerable amounts of nitrogen, potassium and smaller amounts of phosphorus. When manure is used, fertilization rates should be reduced. All manure is variable in nutrient and dry matter content. One factor contributing to this variability is the source of manure. Poultry manure is higher in nitrogen than other sources requiring less to be used. It also provides less organic matter than most cattle manure sources because of its lower straw content.

Sod Covers Between Caliper Trees

Cover crops are one of the best ways of supplying organic matter, controlling erosion and reducing late season growth. Either a temporary or permanent cover crop can be used. A temporary cover crop of Italian rye grass can be seeded between mid-July and early August at a rate of 13-17 kg/ha. The use of soil tests will determine whether additional fertilizer is required to stimulate growth and organic matter production by the rye.

Permanent sod covers using either tall fescue or creeping red fescue may be beneficial. These grass species are not very vigorous or competitive and are also tolerant of drought and resistant to machinery damage in early spring and late fall when soil compaction problems occur. The grass strip between rows can be mowed short while a grass-free strip down the plant row can be maintained through the use of herbicides.

FIELD NURSERY STOCK FERTILIZATION

Fertilization is an important part of producing nursery stock. Without the addition of fertilizer, optimum growth cannot be achieved and maximum profit per time per unit of land will not be realized.

There is no adequate chemical test for soil nitrogen because nitrogen levels in the soil fluctuate rather quickly. Thus, recommendations are not based on soil test values. Use the phosphorus/potassium Table 10 as a guide for requirements of phosphorus and potassium. These values relate only to samples tested by OMAF accredited soil testing laboratories.

Seed Beds, Transplant Beds

These are used for seedlings, rooted cuttings or grafts with the plants usually remaining in the beds for 2 years. The incorporation of organic matter, such as rotted barnyard manure or compost is useful at a rate of approximately 45 tonnes per hectare prior to planting. Green manures grown on the land are also a good source of organic matter.

Adding fresh, undecomposed organic matter that is low in nitrogen will require the incorporation of nitrogen to compensate for microbial decomposition. If fresh sawdust is to be used, apply 15 kg per tonne of actual nitrogen and incorporate.

When preparing the area, incorporate phosphorus and potassium as indicated by soil test (see phosphorus/potassium table on page 15). Prior to planting in the spring incorporate approximately 50 kg of actual nitrogen per hectare if manure is not used. If manure is used, additional nitrogen may not be required the first season; however, it may be used if the decision is based on the grower's previous experience with the crop. In early spring of the second season apply phosphorus and potassium at levels indicated by the soil test and nitrogen at the rate of 50-75 kg per hectare. Individual growers may wish to increase nitrogen applications based on trials for particular species under their growing conditions.

Established Field Stock

Fertilizer application should be based on soil test recommendations. Table 12 may be used for phosphorus and potassium. Nitrogen, for which no good test is available, is either utilized quickly or is easily lost by leaching. Nitrogen applications of 100 to 150 kg of actual nitrogen per hectare per season are recommended. Individual growers may wish to increase nitrogen applications based on trials for particular species under their growing conditions. More nitrogen and potassium fertilizer will be required to maintain optimum levels of fertility in sandy soil than in clay. When no soil test is available, applications of a 3-1-2 ratio fertilizer at the rate of 100 kg actual nitrogen per hectare are suggested.

Fertilizer may be applied in the spring 2 to 4 weeks prior to the resumption of growth and in the fall after top growth has ceased (mid-September to mid-October). So long as soil temperatures remain above 5°C, roots will continue to grow and absorb nutrients. Research indicates that growth during the season after fall fertilization is significantly better than after fertilization in the spring of the same season.

Apply no more than one-half of the total fertilizer required for the season in the fall.

Do not apply fertilizer in late fall or winter, because the fertilizer may be lost through runoff and will not be absorbed because of the cold soil temperatures. High rates of nitrogen should not be applied between mid-July and early September to avoid the possibility of stimulating succulent growth in the fall, unless nitrogen is being applied in small amounts regularly throughout the growing season or it is a slow release formulation.

TABLE 7. NITROGEN EQUIVALENCY TABLE

Fertilizer recommendations are often based on kg of actual (elemental) nitrogen. By using the following calculation you can determine the application rate of any nitrogen fertilizer formulation. For example:

To apply 0.5 kg actual N/100 m^2:

$$\frac{100}{\%\ \text{Nitrogen in the fertilizer}} \times 0.5\ \text{kg N/100 m}^2 = \text{kg fertilizer/100 m}^2$$

To convert to kg/ha multiply by 100

To obtain 0.5 kg N/100 m²	
Nitrogen % in the fertilizer	**kg/100 m²**
5	10
6	8.33
7	7.14
8	6.25
9	5.55
10	5.00
11	4.55
12	4.16
13	3.84
14	3.57
15	3.33
16	3.12
17	2.94
18	2.77
19	2.63
20	2.50
21	2.38
22	2.27
23	2.17
24	2.08
25	2.00
26	1.92
27	1.85
28	1.79
29	1.72
30	1.67
31	1.61
32	1.56
33	1.50
34	1.47
35	1.43
46	1.09

TABLE 8. NITROGEN SOURCES

Nitrogen Materials	% Nitrogen (N)
Ammonium nitrate	33 to 34
Urea	45 to 46
Ammonium sulfate	20
calcium nitrate	17
sodium nitrate	16
Potassium nitrate	13

TABLE 9. PHOSPHORUS SOURCES

Phosphorus Sources	P_2O_5 %
Superphosphate	20
Triple superphosphate	44 to 46
Monoammonium Phosphate	48 to 52
Diammonium Phosphate (18-46-0)	46

TABLE 10. POTASSIUM SOURCES

Potassium Sources	K_2O %
Potassium chloride (muriate)	60 to 62
Potassium sulfate	50
Sulfate of Potash magnesia (11% Mg)	22
Potassium nitrate	44

TABLE 11. PHOSPHORUS AND POTASSIUM REQUIREMENTS FOR FIELD NURSERY STOCK*

PHOSPHORUS (0.5 N Sodium Bicarbonate)			POTASSIUM (1 Normal Ammonium Nitrate)	
Soil Test Value ppm	**Phosphate (P_2O_5) Required kg/ha**		**Soil Test Value ppm**	**Potash (K_2O) Required kg/ha**
	New Planting	**Established**		**New or Established**
0-3	140 L	100 L	0-15	130 L
4-5	130 L	90 L	16-30	120 L
6-7	120 L	80 L	31-45	110 L
8-9	110 L	70 L	46-60	100 L
10-12	100 L	70 L	61-80	90 L
13-15	90 L	60 L	81-100	80 L
16-20	70 M	50 M	101-120	70 M
21-25	60 M	40 M	121-150	60 M
26-30	50 M	30 M	151-180	40 M
31-40	40 M	20 M	181-210	0 H
41-50	0 H	0 H	211-250	0 VH
51-60	0 VH	0 VH	250 +	0 E
61-80	0 E	0 E		
80 +	0 E	0 E		

L — Low *M — Medium* *H — High* *VH — Very High* *E — Excessive*

**Approved by the Ontario Soil Management Research Committee. Effective November 1, 1990.*

NURSERY CONTAINER CULTURE

Pots

Pots used for container growing are most commonly constructed of high density plastic. Fibre pots are not recommended for long-term growing because they begin to soften, decompose and may be damaged by rough handling. However, fibre pots are useful for short-term growing and field potting for winter storage or spring shipping. All currently distributed potting machines will accept plastic and fibre pots.

Pot color will affect the temperature of the mix and root development. Several studies have shown that black and dark green pots are as much as 10°C hotter than white or light reflective pots, reaching a maximum of nearly 40°C on the inner surface of the sunny side. When media temperatures approach 30°C root growth decreases. However, pots with a white or reflective exterior are not widely available. They would be useful along the outside rows of a block or for widely spaced plants. In the center of a pot-to-pot block, sunlight will not strike the pot wall. To diagnose high temperature injury, remove the pot and compare root growth on the sunny and shaded sides of the pot.

Root circling is a potential problem in circular pots, although not for most of the stock currently grown in Ontario for landscaping purposes. Square pots or vertical ribs will help to reduce root circling and increase root branching. However, very few large pots of such design are available.

Mixes

Potting mixes are a very critical component in a successful container-growing operation. The importance of adequate aeration cannot be overemphasized. Water-holding ability is also important but is a secondary factor compared to aeration. Since roots require adequate oxygen to grow properly, a poorly aerated mix will restrict root growth of plants because of insufficient oxygen.

Total porosity of a mix is the amount of spaces between particles that could potentially be filled with either air or water. A value above 50% is adequate for total porosity. Total porosity is the amount of space in the mix filled with air after irrigation water has drained out. The method of determining media porosity is outlined on page 17.

If aeration porosity is as low as 15%, the mix is poorly drained. Values above 30% are considered too high. Too much aeration is not bad but it means that frequent irrigation will be necessary. A mix with a high percentage of very fine particles (i.e. <.5 mm) results in low aeration porosity and poor drainage.

Mix ingredients should be free of insect, disease and weed pests, readily available to assure a continuous supply and should not be overly expensive. Also the mix should not be so lightweight that potted tall plants blow over in the wind.

Peat has been the traditional mix ingredient combined with equal parts of concrete grade sand. However, such a mix becomes alkaline when a high pH sand is used and aeration is somewhat low.

Bark is a common mix ingredient. It provides good aeration when combined with equal parts of peat. Mixes such as 2 parts bark and 1 part peat or 2 parts bark and peat and 1 part sand provide adequate aeration and water-holding capacity. Another advantage of bark is that it helps to control root rot disease organisms. Coarse sawdust that is well decomposed is also useful as a mix ingredient. Fresh sawdust should be avoided because of its very high carbon/nitrogen, C/N ratio. The C/N ratio of sawdust is 1000/1, of conifer bark 300/1 and of hardwood bark 150/1.

Before making the potting mix, stockpile the mix for several months and turn it occasionally.

To compensate for the high C/N ratio and to enhance decomposition add approximately 1 kg of actual N (e.g., ammonium nitrate) per cubic metre of bark. Hardwood bark will decompose more quickly than conifer bark.

pH

Media pH should be between 5.5 and 7.0. Although *Juniperus* and *Thuja* will grow adequately at a higher pH, plants such as *Euonymus, Rhododendron* and *Taxus* will exhibit iron and/or manganese chlorosis if the pH is above 7.0. With pH-sensitive crops, do not use alkaline sand in the mix. Irrigation water can be acidified with nitric or phosphoric acid, depending on the bicarbonate content of the water. Also, acidifying fertilizers may help to control pH. For those using injectors, fertilizer and acid concentrates should be applied as separate solutions.

TABLE 12. MATERIALS FOR ACIDIFYING A MIX

Materials	kg/100 m² To Lower pH 1/2-1 Unit[1]	Rate of pH Change
Finely Ground Sulfur	2.5 kg	slow
Iron Sulfate	15 kg	moderate

[1] Rates are for coarse- to medium-textured soils. For fine-textured soils with more organic matter, increase rate by one-third. The rates per m³ of potting soils are one-half the above recommended rates.

Fertilizers

Since most container mixes contain little or no soil, their fertility is quite low. Consequently, fertilizers must be added. The most common methods of fertilizer applications are liquid or control release.

Liquid feeding with totally water-soluble fertilizers is applied through the irrigation system. In theory, soluble fertilizers should be applied at every watering, but results seem to indicate little difference in growth between constant and intermittent fertilizing. This type of fertility program requires an accurate concentrate diluter in the irrigation system. However, while this method may be accurate, it is not the most efficient use of water and fertilizer.

In recent years, the impact of fertilizers on the environment and groundwater has become an important concern of agriculture and growers should evaluate their fertilizer program in order to achieve maximum efficiency and minimum environmental impact.

Commercial water-soluble fertilizers are available in numerous analyses (i.e. 20-20-20 or 28-14-14). Use at the rate of 200 ppm nitrogen (100 g of 20-20-20 per 100 L of water) for constant feeding. Increase the rate to 400 ppm for infrequent or intermittent fertilizing.

Method of Determining Media Porosity

You will need: (1) your normal pot; (2) a way to cover or plug the pot drain holes; (3) a graduated cylinder or other liquid measure; and (4) some dry mix. Use this method to test new mixes. Plant growth in your standard mix and a new one, each with its respective aeration value, will be your guide as to the best mix. Select mixes with high aeration porosity (in the range of 20-25) for items such as pine and yew. Somewhat lower values can be tolerated by junipers and white cedar.

1. With the drain holes covered or plugged fill the container with water to the normal potting level. This amount of water is total container volume (A).
2. Empty the water and fill the pot with a nearly dry mix. Be sure the pot is level. Add water very slowly until a slick of water appears on the surface. The water added is (B), the pore volume. Record the amount of water added.
3. Without moving the pot remove the drain hole covers or plugs, allowing the water to drain into a bucket. Measure the water drained (C), the aeration pore volume.

$$\text{Total porosity} = \frac{B \times 100}{A}$$

$$\text{Aeration porosity} = \frac{C \times 100}{A}$$

— To determine the water retention porosity, which is similar to the moisture at field capacity of a soil, subtract aeration porosity from total porosity.

— Example
pot volume = 5180 mL (A)
water added to saturate mix = 3354 mL (B)
water drained when holes uncovered = 1080 mL (C)

Total porosity = 65%

$$\frac{3354}{5180} \times 100 = 65\%$$

Aeration porosity = 21%

$$\frac{1080}{5180} \times 100 = 21\%$$

Water retention porosity = 44%
65 – 21 = 44%

Calculation of Parts Per Million (PPM) in a dilute liquid feed

$$\text{ppm nutrient} = \frac{\text{weight of fertilizer (in kg)} \times \% \text{ nutrient (in fertilizer)} \times 10000}{\text{volume of stock solution (in litres)} \times \text{dilution rate}}$$

Calculation of weight of fertilizer required per litre of stock solution to obtain a given level of nutrient in the dilute feed.

$$\text{kg of fertilizer per litre} = \frac{\text{ppm (of diluted feed)} \times \text{dilution rate}}{\% \text{ nutrient (in fertilizer)} \times 10000}$$

If water-soluble fertilizers do not contain minor elements, they should be added to the mix prior to potting or as soluble trace elements during the growing season. Dry materials with added bulking agents are less concentrated and thus easier to blend into the mix; use them as recommended by the manufacturer.

There are several slow or control-release fertilizers available for containerized production of nursery stock. These materials may be incorporated when making the potting mix or topdressed later. Use at the manufacturer's suggested rates. When preparing the mix, avoid excessive incorporation which may breakdown the particles and result in fertilizer toxicity. If these potting mixes are to be stored outdoors for an extended period of time, the pile should be covered to prevent leaching.

Using control release materials, which usually contain no micronutrients, will require the addition of trace elements (manufacturer's recommendation). Superphosphate is often recommended by the manufacturers of some control-release fertilizers, because of inadequate phosphorus release. There are several formulations now available which do include micronutrients.

Research trials indicate the supplemental fertility, particularly with nitrogen, may be beneficial for some crops grown with pre-incorporated fertilizers. Apply nitrogen at the rate of 200 ppm if nitrogen readings from soil tests are low. During the second growing season following the use of pre-incorporated slow-release materials, nutrients may be supplied by water-soluble fertilizers in the irrigation system or surface-applied fertilizers. Research has shown that *Juniperus*, in mixes with low aeration porosity, grew better the first year with a pre-incorporated fertilizer. When the plant is small and growing in a 6 L pot, the need to water in order to fertilize may result in poor growth due to low aeration.

Soil tests are an important part of a container production operation. Potting mixes do not retain nutrients and the quantity of water applied causes rapid leaching. Biweekly sampling is suggested. Once the grower becomes familiar with test results, pH and salt readings may provide sufficient information at each sampling. Nutrient analysis can be less frequent. When using water-soluble fertilizers, salts are normally lower than that of pre-incorporated control-release fertilizers (both used at the recommended rates).

Fertility control of container-grown plants in the garden centre is important to ensure proper growth, particularly if the plants have been grown previously under a liquid fertilizer program. Add a control-release fertilizer at the manufacturer's recommendation. Do not add fertilizer on the surface prior to shipping.

Soilless Media and Nutritional Guidelines

Soilless media have distinctly different chemical and physical properties when compared with field soils. Media are now peat- or bark-based with good moisture-holding and aeration properties but they have limited nutrient-holding capacity. Fertility management is important if the maximum growth potential of crops is to be achieved. The fertilization guidelines listed in Table 13 are based on the saturated media extract procedure. This procedure was adopted because a single set of guidelines could be established, since the amount of water held at saturation is directly related to the moisture-holding characteristics of each medium.

Avoid growing media with pH above 6.5. High pH affects the availability of most micronutrients. High pH values, resulting from the addition of coarse sand, may lead to low levels of calcium and magnesium. Soluble calcium levels can be increased by adding fine dolomitic lime or gypsum.

Nutrient Levels for Container Grown Crops

Table 13 contains recommendations for adjusting a fertilizer program based on media water-soluble nutrient levels obtained from soil test reports issued by OMAF accredited laboratories. The nutrients are reported as the amount available in parts per million (ppm) and the recommendations are based on a normal feeding program. Soil test results may be inconsistent when encapsulated fertilizers (control release) are used in the fertilizer program due to the breaking of the capsules during sampling, shipping or testing.

Current soil tests measure only nitrate nitrogen, ammonium nitrogen in the mix is not detected. Woody plants utilize both nitrate and ammonium forms, with nitrate being more important, except for such plants as oak, ericaceous plants, and conifer seedlings. Under most conditions during the summer, the ammonium forms of nitrogen are quickly converted to nitrate nitrogen by the microorganisms present in the media.

TABLE 13. SOIL NUTRIENT LEVELS FOR MOST CONTAINER CROPS

Nitrogen — as water-soluble Nitrate (NO_3) N	
Low 0-39 ppm	Add additional nitrogen to feeding program, if using slow-release materials.
Normal 100-199 ppm	Continue feeding program at high levels. Check total salts.
Excess above 250 ppm with high salts	Discontinue feeding, check total salts. Root damage may occur. Higher rates of fertilizer may be required to give optimum growth in a bark mix and also to maintain the same soil test level as in a peat mix.
Phosphorus — as water-soluble P	
Low 0-2 ppm	Add additional phosphorus to feeding program.
Normal 6-9 ppm	Continue feeding program at high levels. Check total salts.
Excess above 50 ppm	Discontinue feeding phosphorus.
Potassium — as water-soluble K	
Low 0-59 ppm	Add additional potassium to feeding program.
Normal 150-250 ppm	Continue feeding program at high levels. Check total salts.
Excess above 350 ppm	Discontinue feeding and leach (leaching is not effective for incorporated slow-release fertilizer). Somewhat higher levels may be tolerated if the mix contains a high proportion of organic material.
Total Salts — mS/cm (mhos X 10^{-3})[1]	
Low 0-0.75	Check for adequate nitrogen and potassium levels.
Normal 2.0-3.5	Continue feeding program.
Excess above 3.5	Discontinue feeding. Higher levels may be tolerated if the mix contains a high proportion of organic material.
Calcium — as water-soluble Ca	
Low 0-79 ppm	Apply additional soluble calcium to fertilizer program.
Normal 200-300 ppm	
Excess above 400 ppm	Calcium levels are easily raised by adding dolomitic lime or gypsum to the media.
Magnesium — as water-soluble Mg	
Low 0-29 ppm	Apply 0.5 kg/1000 L magnesium sulfate through the irrigation water.
Normal 70-200 ppm	
Excess over 200	
Miscellaneous	Sulfate levels should be below 300. Chlorides should be below 50 and pH between 5.0 and 6.5.

[1] *Several notations may be used to express Total Salts : millimhos/cm (mmhos/cm); milli-Siemens/cm (mS/cm); EC x 10^{-3}; parts per million (ppm).*

mmhos/cm = mS/cm = EC x 10^{-3}

To convert ppm to mmhos/cm, divide by 700 (mmhos/cm = ppm ÷ 700)

To convert mmhos to ppm, multiply by 700 (ppm = mmhos/cm x 700)

FERTILIZING LANDSCAPE PLANTINGS

Fertilization is a cultural practice which should be carried out as warranted by the soil characteristics, the type of plant and the growth desired. Most of our natural soils have enough inherent fertility to allow plants to grow adequately. An application of fertilizer may be needed to aid establishment after transplanting or to maintain vigor. If landscape plants are growing well, there is no need to fertilize them. At planting superphosphate (1.5 kg per cubic metre of backfill) is recommended. Trees growing in lawn areas benefit from fertilizer applications to the grass. Apply a herbicide-free turf fertilizer at a rate somewhat higher than that recommended for the grass.

Any complete fertilizer which is high in nitrogen is fine for trees and shrubs. Most studies indicate that plant growth is more responsive to nitrogen than phosphorus and potassium. The required amount of fertilizer should be evenly distributed on the soil surface beginning well beyond (as much as 2 times) the branch spread and extending inward to two-thirds the distance between the dripline and the trunk. If part of the area under the branch spread is obstructed by paving, reduce the quantity of fertilizer applied accordingly. Applications may be split during the year with no more than one-half the annual rate applied in the fall. Pressure injection of slow-release fertilizer into the soil is acceptable. The drill hole method of tree fertilization may be used if the soil is in need of aeration or when it is important not to overestimate the vegetation growing on the surface.

The two best times to fertilize are the early spring before growth begins and the fall after the danger of growth stimulation has passed. Avoid using large quantities of a quick-release fertilizer between mid-July and early September. Applications may be split during the year with no more than one-half the annual rate applied in the fall. Additional information on landscape fertilization is found in OMAF Factsheet, *Fertilizing Trees and Shrubs in the Landscape*, Agdex 270/542.

Rates

The following recommendations on rates for trees and shrubs should be used as an approximate guide. Low tree vigor, a long growing season and well-drained sandy soil may necessitate higher rates. Apply nitrogen at 1.5 to 2.0 kg per 100 m^2 using a nitrogen only or a high nitrogen complete fertilizer. Water thoroughly after application.

NURSERY STOCK

INSECTS AND MITES AFFECTING TREES AND SHRUBS

All plants are subject to attack by one or more species of insect or mite. The potential for injury exists throughout the growing season from the first warm days of spring until the freezing weather of autumn. Fortunately, most of the time natural control factors keep pest populations at a level where plants are not damaged. However, conditions favorable for the multiplication of one pest or another occur from time to time and artificial control measures must be applied if serious injury is to be prevented.

In order that these measures may be as effective, safe and economical as possible, it is necessary to detect changes in pest numbers and activity at an early stage of development. This is accomplished by frequent inspection of the plants. In addition, it is necessary to be able to identify the pest concerned, and know how and when to best deal with it.

The following information has been compiled to help meet these objectives. An excellent publication complete with photos and life cycles of pests titled *Common Pests of Trees in Ontario* is available from the Ontario Ministry of Natural Resources.

DESCRIPTION OF PESTS AND DAMAGE CAUSED

Insect and mite pests may best be considered according to the manner in which they feed and the damage they cause. The following broad groupings have been selected: defoliators, sucking insects, borers, and gall makers. Often the damage is so characteristic that the casual agent may be identified without actually seeing the pest at work. Indeed, some pests, particularly mites, are so small that they cannot readily be seen by the unaided eye. Other pests develop within the tissues of the plant and are thus concealed.

DEFOLIATORS

This group of insects eats solid foliage tissue. Their habits are quite diverse: they may consume entire leaves or only the interveinal tissue; skeletonize only one surface or mine between the leaf surfaces; feed singly or in dense colonies; develop exposed or within the protection of a web, folded leaf, or portable shelter. Reduction of leaf area through defoliation stops, or interferes with the elaboration of food materials by the photosynthetic process, with transportation, and with the translocation of food within the tree. Some of the more common defoliators are listed below.

LEAF-CHEWING CATERPILLARS
(the immature stage of moths or butterflies)

Fall cankerworm, *Alsophila pometaria*, and the **Spring cankerworm,** *Paleacrita vernata*, occur in mixed infestations early in the season. They are greenish-to-black loopers and attack the foliage of a wide range of deciduous hosts.

Eastern tent caterpillar, *Malacosoma americanum*, forms the familiar silken tent in the forks of branches mainly of apple, cherry and hawthorn trees. The **Forest tent caterpillar,** *Malacosoma disstria*, does not form a tent but may completely defoliate broadleaved trees, particularly poplars, over a wide area. Both species are present early in the season, and the larvae feed in colonies.

Fall webworm, *Hyphantria cunea*, forms a large web in late summer over the ends of branches of ash, box-elder, flowering crab and many shade trees. The caterpillar is pale yellowish-green and very hairy.

Birch skeletonizer, *Bucculatrix canadensisella,* is a small yellowish-green larva which feeds on the undersurface of the leaves from mid- to late summer. Only birches and possibly alders are attacked.

Greenstriped mapleworm, *Dryocampa rubicunda rubicunda,* has a cherry-red head and a yellowish body with seven dark lines running its entire length. Its preferred hosts are maple, oak and box-elder.

Gypsy moth, *Lymantria dispar,* caterpillars are dark and hairy with 5 pairs of blue tubercles or spots followed by 6 pairs of red tubercles along their backs. Caterpillars feed in the spring and early summer, reaching about 6 cm in length when mature. They consume the foliage of a wide range of trees and shrubs, but prefer basswood, birch, hawthorn, oak, poplar and willow.

Hemlock looper, *Lambdina fiscellaria,* is a grayish caterpillar flecked with black dots and about 30 mm long. It prefers hemlock, balsam fir and white spruce, but will feed on several other coniferous and broadleaved hosts.

Juniper looper, *Thera juniperata,* is a greenish caterpillar with a whitish and reddish line along each side. It feeds on juniper during September.

Juniper webworm, *Dichomeris marginella,* is a light brown, 12 mm long caterpillar. It feeds at the base of the needles and webs them together during early fall and again the following spring.

Leafroller is a caterpillar that feeds in concealment which it provides for itself by folding or rolling leaves together. **Fruit tree leafroller,** *Archips argyrospilus,* and **Redbanded leafroller,** *Argyrotaenia velutinana,* are primarily pests of fruit trees but also attack a wide range of shade trees and ornamentals.

Linden looper, *Erannis tiliaria,* is bright yellow with a rusty brown head and 10 wavy black lines down the back. It is present from early spring until July and attacks a wide variety of hardwoods.

Maple trumpet skeletonizer, *Epinotia aceriella,* which attacks sugar, red, and silver maple, spins a long trumpet-like tube of silk and frass on the underside of a leaf, causing the leaf to fold around it. It feeds from within this tube and skeletonizes the part of the leaf covered by the web, causing it to crumple. Larvae are present from late July to September. It may also attack hawthorn and beech.

Oak leaftier, *Croesia semipurpurana,* is a small, whitish larva which enters unopened buds in May and feeds on the young leaves, later tying the leaves together and shredding the tissue. It only attacks oaks.

Oak skeletonizer, *Bucculatrix ainsliella,* is a small yellowish-green larva which feeds on the lower surface of oak leaves. There is one generation in June and a second in August and September.

Orangestriped oakworm, *Anisota senatoria,* is black with orange or yellow stripes running lengthwise down the sides and back. Two stiff black horns project from the top of the second body segment, and there are small sharp spines on the other body segments.

Pine webworm, *Tetralopha robustella,* is yellowish-brown with two dark longitudinal stripes on each side. Colonies of the larvae feed during midsummer on needles enclosed within masses of coarse webbed frass on twigs and branches.

Spiny elm caterpillar, *Nymphalis antiopa,* is also commonly known as the mourning cloak butterfly in the adult stage. The larva is black with scattered white dots, and the body is covered with many large, branched spines. They feed gregariously on elm, willow and poplar.

Spruce budworm, *Choristoneura fumiferana,* has a black head and brownish body with 4 light spots on the back of each segment. It is a widespread and important defoliator of balsam fir and spruce, beginning to feed as buds break and continuing until mid- to late June. There is only one generation per year.

Walnut caterpillar, *Datana integerrima,* is black with long gray hairs, and is the most important leaf eater of walnut and hickory. The caterpillars descent down tree trunks as a colony to molt and thus leave a conspicuous clump of gray cast skins on the trunk. Adult moths lay eggs in early July with larvae feeding until the end of August.

LEAF-EATING BEETLES

Elm flea beetle, *Altica ulmi,* is a small, metallic blue-colored beetle that eats holes through elm leaves soon after they unfold in the spring. The larvae are small, blackish grubs that skeletonize the underside of the leaves.

Elm leaf beetle, *Pyrrhalta luteola,* is olive green with a dark stripe on each wing cover. The beetles chew holes in the developing leaves and the black larvae skeletonize the underside. All species of elm may be attacked.

Imported willow leaf beetle, *Plagiodera versicolora,* is a small, oval-shaped, metallic blue beetle. Both the adults and the larvae skeletonize the leaves of willow and Lombardy poplar. There are two or more generations a year. The larvae are black, slug-like grubs.

Japanese beetle, *Popilla japonica,* metallic green adults are about 13 mm in length. It is readily recognizeable by its 6 tufts of white hairs on each side of its abdomen. As the beetle feeds it skeletonizes and consumes foliage. Members of the *Rosaceous* family are prefered hosts as well as maple, birch, and linden and fruit trees.

Rose chafer, *Macrodactylus subspinosus,* is a slender, long-legged, tan-colored beetle, densely covered with short, dull yellow hairs. They appear in swarms in early June and feed on the opening buds of a wide variety of hosts. Later they attack the flowers, fruit and foliage. The larvae feed mostly on the roots of grasses but may also attack the roots of tree seedlings.

SAWFLIES

The adults of sawflies are 4-winged insects often resembling small, amber-colored bees. The larvae of most species are caterpillar-like with more than 5 pairs of prolegs. They feed in colonies and strip the foliage from the host plants in a short time, usually during June and July. Some common species are **larch sawfly,** *Pristiphora erichsonii,* **mountain ash sawfly,** *Pristiphora geniculata,* and **privet sawfly,** *Macrophya punctumalbum.*

Several species of sawflies attack pines. The **European pine sawfly,** *Neodiprion sertifer,* has a dark greenish body with black head and dark longitudinal stripes on the body. It is present from late May through June.

Redheaded pine sawfly, *Neodiprion lecontei,* has a yellow body with six rows of black spots and a reddish head. It is present during July and August. It usually feeds on older foliage but where more than one generation is present, all foliage is attacked.

Larvae of the **pearslug,** *Caliroa cerasi,* and **roseslug,** *Endelomyia aethiops,* resemble small naked snails. Their tadpole-shaped bodies are covered with a slimy, olive green material secreted by them. They skeletonize the leaves, making them appear scorched and causing them to drop prematurely.

LEAFMINERS AND CASEBEARERS

Larvae of these insect groups are concealed during the greater part of their development within the tissues of the leaves or within a protective case made of leaf fragments which they carry to the feeding site. The tunnels of leafminers may be straight, serpentine or blotch, and are sufficiently characteristic to permit identification of most species.

Arborvitae leafminers constitute a complex of 4 species of caterpillars of which *Argyresthia thuiella* is the most common. Feeding causes the branch tips to turn brown. Adult is a small, light gray moth that appears in late June and early July.

Bagworm, *Thyridopteryx ephemeraeformis,* is readily recognized by its curious spindle-shaped feeding case of loosely constructed leaf fragments. It attacks a wide range of coniferous and deciduous trees.

Birch leafminer, *Fenusa pusilla,* forms a blotch mine involving half or more of each leaf. Foliage of heavily infested trees appears to have been scorched. There are at least two generations a year. Adult is a small, black fly that emerges from the soil when the first birch leaves are half grown.

Lilac leafminer, *Caloptilia syringella,* primarily damages the foliage of black locust in both the adult and larval stages. Heavy infestations render trees very unsightly. There may be two generations a year. The adult is a small, wedge-shaped black beetle with wing covers of bright orange.

Spruce needleminer, *Taniva albolineana,* bores into the bases of old needles. Young larvae feed gregariously, older larvae singly. Unsightly nests are constructed of dead needles and frass held together by fine strands of silk. Small, gray moths may be observed throughout infested plants in late May and June.

SUCKING INSECTS

This group of pests weakens trees and shrubs by sucking out the sap, and frequently injecting secretions which injure or kill plant cells. Most species are small and inconspicuous; nevertheless, some are among the most troublesome of pests. Because the foliage is not torn or broken, plants may become infested and severely injured before the pest is known to be present. Signs of damage are mottling and fading of leaf color, curling and twisting of leaves, wilting of foliage and tender shoots, hardening of flower buds and malformation of flowers. Sucking insects include aphids, lacebugs, leafhoppers, mealybugs, mites, scales, spittlebugs and thrips.

APHIDS

Aphids or plant lice are small, soft-bodied, pear-shaped insects that may vary from green to shades of red, brown or black. They may attack a plant both above and below the ground, but commonly cluster on new growth or on the underside of leaves. Aphids secrete a sweet, sticky substance called "honeydew." This attracts ants, flies and wasps, and is a nuisance when it coats objects beneath infested plants. A black, sooty mold may grow on the honeydew, making plants unsightly.

Some species, such as **beech blight aphid,** *Fagiphagus imbricator,* **pine bark aphid,** *Pineus strobi,* and **woolly larch aphid,** *Adelges lariciatus,* have a body covered with conspicuous cottony threads.

Many aphids have very complex life histories, involving several generations a year, alternate host plants, and winged and wingless forms which may lay eggs or give birth to living young.

Honeysuckle aphid, *Hyadaphis tataricae,* causes early season curling and dwarfing of apical leaves of *Lonicera,* especially *L. tatarica* Rosea and *L. korolkowii zabelii.* The affected portion of the branch may reach several centimetres in length. Eventually the affected stem will die, resulting in the typical witch's broom malformation which may completely disfigure heavily affected bushes. Dead shoots are particularly evident in the spring following attack.

LACEBUGS

These flat, rectangular insects are about 4 to 6 mm long, and are dark with broad, transparent, lace-like wing covers. Both adults and nymphs feed on the underside of leaves. They extract so much plant juice that leaves become pale and mottled with white splotches. The lower surfaces of leaves are spotted with black and brownish dots. Heavily infested leaves may turn entirely brown and fall off. Most species have two generations a year. Lacebugs usually occur on a single host. Trees commonly attacked are ash, elm, hickory, linden, oak and walnut.

LEAFHOPPERS

Leafhoppers are small, wedge-shaped active insects that run, hop, or fly when disturbed. They are usually a greenish or yellow color, although a few kinds are striped. Leafhoppers feed on the underside of leaves, causing them to become light in color and marked with small white dots on the upper surface. Often the cast skins of the nymphs remain attached to the lower surface of a leaf and their presence helps identify the cause of injury. Woody hosts most commonly injured by leafhoppers are apple, elm, honeylocust, maple and rose.

MITES

Mites are not insects, but tiny animals closely related to spiders and ticks. Sometimes called "spider mites," they produce webbing between the needles or leaves which protects them from dislodgement as well as from their natural enemies. Mite activity causes speckling, bleaching or bronzing of the foliage, and spotting with tiny spherical eggs or broken eggshells. In severe infestations the foliage may drop prematurely, killing the plant. Mites have a high reproductive capacity and their numbers increase rapidly during hot, dry weather. Since plants may be seriously

damaged in a short period of time, it is important to determine early in the season if mites are present on plants. Because most mites can barely be seen with the naked eye, hold a sheet of white paper under a branch, and tap it sharply. Some mites will drop onto the paper and can be seen as tiny specks as they crawl about. Evergreens and deciduous trees are both subject to mite attack, and there may be several generations a year.

Mite species commonly associated with trees are: **clover mite,** *Bryobia praetiosa,* on the honeysuckle and elm; **European red mite,** *Panonychus ulmi,* on apple, mountain ash and elm; **honeylocust mite,** *Platytetranychus multidigituli,* on honeylocust; **Oak red mite,** *Oligonychus bicolor,* on oaks; **pear leaf blister mite,** *Eriophyes pyri,* on mountain ash; **spruce spider mite,** *Oligonychus ununguis,* on spruce, hemlock arborvitae, and juniper; **twospotted spider mite,** *Tetranychus urticae,* on elm, linden, rose, and ornamental fruit trees; and several species of **rust mite** on elm, honeylocust, maple, oak and privet.

NOTE: Because mites are not insects, they are not effectively controlled by all insecticides. Therefore, it is often necessary to employ a material formulated specifically for the control of mites. Some of the common miticides, or acaricides, are Kelthane, Pentac, and Morestan. These should be used according to the manufacturer's directions on the container label.

SCALES

Scale insects are inactive during most of their lives. They are quite small and often blend in color with the host plant, so they are hard to find. For ease of identification, scales may be divided into three groups: armored scales, soft or unarmored scales, and mealybugs.

Armored scales are the most common type on trees and shrubs. They secrete a hard, waxy covering over their bodies and may be circular, oblong or pear-shaped. Armored scales vary from 2 to 3 mm in length or diameter.

Oystershell scale, *Lepidosaphes ulmi,* attacks over 125 species of forest, shade, fruit and ornamental trees, and is often particularly important on ash, cotoneaster, lilac and maple. In heavy infestations the grayish scales completely encrust the twigs and stems, and can cause branch and tree mortality. Mature females are 3 mm long, tapered in front and rounded in the rear.

Pine needle scale, *Chionaspis pinifoliae,* appears as whitish drops on the needles of pines and spruces. The crawlers are reddish, but turn yellowish. They appear in late May. There are two generations per year.

Juniper scale, *Carulaspis juniperi,* is a small, circular, white scale that turns the needles of juniper and arborvitae yellow. All species of juniper are attacked including Pfitzer and Savin. Sooty mould fungus sometimes develops.

Euonymus scale, *Unaspis euonymi,* is a grayish, pear-shaped scale infesting euonymus, bittersweet, and pachysandra. It produces two generations a year.

San Jose scale, *Quadraspidiotus perniciosus,* is a small, flat, circular scale with a dark central nipple. It infests a wide range of shade and fruit trees.

Soft scales are either bare or enclosed in waxy or cottony secretions.

Cottony maple scale, *Pulvinaria innumerabilis,* resembles a partially popped kernel of corn. It attacks maple, linden, elm, beech, oak, and other trees and shrubs. It is found on the twigs only. There are two generations per year.

Tuliptree scale, *Toumeyella liriodendri,* is a dark brown, hemispherical scale which attacks several species of deciduous trees.

Pine tortoise scale, *Toumeyella numismaticum,* is a reddish-brown oval, very convex scale about 6 mm long. It attacks several kinds of pine. Injury is caused by the removal of plant sap and the secretion of large quantities of honeydew.

European fruit lecanium, *Lecanium corni,* is a large, reddish-brown, convex scale usually found on the underside of twigs. It infests a wide range of deciduous trees and shrubs.

Fletcher scale, *Lecanium fletcheri,* closely resembles the European fruit lecanium. It attacks yew, arborvitae and juniper.

Spruce bud scale, *Physokermes piceae,* is a globular, mahogany brown scale that clusters at the nodes of spruces. Lower branches become ragged with some die-back.

Golden oak scale, *Asterolecanium variolosum,* feeds in small pits on the twigs, branches and trunks of white oaks.

Mealybugs are soft-bodied and usually covered with a powdery, cottony-wax material. They vary from about 5 to 8 mm in length when full grown. They produce honeydew, but unlike the other kinds of scale insects, they can move about throughout their entire life cycle.

Taxus mealybug, *Pseudococcus cuspidatae,* is a slow moving, white, "woolly" insect which may completely cover branches and trunks of heavily infested plants with a waxy secretion. Feeding discolors the needles and causes excessive needle cast. All species of yew are attacked.

Woolly maple scale, *Phenacoccus acericola,* produces white cottony masses on the underside of sugar maple leaves during the summer. There is more than one generation a year. Linden, ironwood and horse chestnut may also be attacked.

Other sucking insects of importance are: **pine spittlebug,** *Aphrophora cimbrata,* which forms masses of spittle on the branches and trunks of pines; and **thrips** which are tiny, slender-bodied insects mainly affecting the leaves and flowers of honeylocust, privet and pines.

BORERS

At the larval stage, some beetles and moths are called borers because they tunnel into the buds, shoots, bark or wood of trees and shrubs. A few species will attack healthy trees, but most attack trees and shrubs already weakened or injured by some other cause. Often the presence of borers is not evident until it is too late to save the tree; therefore, prevention of injury is most important. Borers frequently girdle and kill branches or whole trees, weaken a tree and make it subject to wind damage, and provide entrance courts for disease fungi. Borer injury is indicated by dark, discolored, dead areas with sap and sawdust-like borings clinging to bark or littering the ground.

Bronze birch borer, *Agrilus anxius,* attacks birch trees which have been injured or are in a weakened condition. The elongated white larva makes long, winding tunnels just under the bark which show as spiral ridges around the branches and trunk. The larvae which usually require two years to complete development emerge as adults from June to August. The adult is a slender olive-bronze beetle.

Elm bark beetles are vectors of the Dutch elm disease fungus.

The **smaller European elm bark beetle,** *Scolytus multistriatus,* feeds in the crotches of small twigs, while the **native elm bark beetle,** *Hylurgopinus rufipes,* attacks rough-barked branches and stems. Both species are small, brownish beetles about 3 mm long.

European pine shoot moth, *Rhyacionia buoliana,* attacks the buds and young shoots of various pines, causing deformed growth or witch's brooming. The larva is brown with a black head. The most important and permanent damage results from their spring feeding on growing shoots. The adult is a small, orange-flecked moth usually active in late June and early July. There is only one generation per year.

Lilac borer, *Podosesia syringae,* is a dark brown, wasp-like moth. The larva bores into lilac, ash, mountain ash and privet generally near the base of the tree.

Locust borer, *Megacyllene robiniae,* is a black and yellow beetle that feeds on the pollen of goldenrod in late summer. The larva is a fleshy, white grub that tunnels in the stems of black locust. Weakened trees break in the wind.

Locust twig borer, *Ecdytolopha insiticiana,* causes irregular fusiform galls on twigs of black and honeylocust. Seedling mortality may be high in heavily infested areas.

Maple petiole borer, *Caulocampis acericaulis,* tunnels in the leaf stems of maple, causing the leaves to break near the blade and fall.

Pales weevil, *Hylobius pales,* is a small, brownish weevil which feeds on the tender bark of pine twigs, causing the terminals to turn brown and die (flagging). The larvae feed in long tunnels along the grain of wood below ground and out on major roots.

Peachtree borer, *Sanninoidea exitiosa,* and **lesser peachtree borer,** *Synanthedon pictipes,* attack various cultivated and ornamental *Prunus.* The adults of both are clear-winged moths. The former species works at the base of trees while the latter develops higher in the scaffold limbs. The borers overwinter as partly grown larvae in the bark or wood. Feeding resumes in spring with masses of gum and castings accumulating near the burrows.

Poplar-and-willow borer, *Cryptorynchus lapathi,* is a stout, black, rough-bodied snout beetle. The outer half of the wing covers is pink. The white, legless larva honeycombs the trunk and larger branches of willows and poplars.

Sugar maple borer, *Glycobius speciosus,* is a robust, black, longhorned beetle with 5 yellow bands on the wing covers. The fleshy white larva cuts deep channels in the wood. Cracked, swollen areas resembling cankers are external indications of infestation. It has a two year life cycle.

Twig pruner, *Elaphidionoides villosus,* breeds in the twigs of oak, hickory, maple, and several other hardwoods. The larva bores down the center of a twig, then severs the branch so that it breaks in the wind. Trees are disfigured but seldom killed.

White pine weevil, *Pissodes strobi,* is a small, brownish snout beetle that attacks only the vertical terminals of pines and spruces, killing at least 2 years growth. Attacks result in crooked, forked or multiple-stemmed trees.

GALL MAKERS

Galls are abnormal vegetative growths produced by a tree as a reaction to insect irritations or stimuli, such as feeding, stinging, egg-laying, or injection of toxins. This reaction is generally beneficial to the pest rather than to the tree as it provides a protective feeding site. Galls vary greatly in size, color and complexity, but each insect species produces a characteristic gall formation. Galls may be formed on any part of a tree. Oaks and hickories are the favourite hosts for several hundred different gall insects. They adversely affect the appearance and shape of trees and may kill leaves and branches, but whole tree killing is not common. Galls are produced by aphids, mites, midges, gall wasps, and sometimes by the larvae of beetles and moths.

APHIDS

Cooley spruce gall aphid, *Adelges cooleyi,* induces formation of elongate galls on the current year's shoots of Colorado blue, Engelmann, and Sitka spruce. In an alternate host, Douglas fir, it causes needles to twist and turn yellow, but does not form a gall.

Eastern spruce gall aphid, *Adelges abietis,* induces pineapple-shaped galls to form at the base of the current year's shoots of Norway, white, red and black spruce. Old galls remain attached for long periods, turning black and imparting a scraggly appearance to the tree.

Hickory gall aphid, *Phylloxera caryaecaulis,* produces almost spherical galls, about 16 mm in diameter, on the twigs and leaf stems of hickory. Girdled twigs die and break at the point where a gall occurs.

MITES

Ash flower gall mite, *Eriophyes fraxiniflora,* is active when the male flower buds of ash break in the spring. It feeds on the unfolding tissues, causing them to form irregular clusters of galls 12 mm in diameter.

Maple bladder gall mite, *Vasates quadripedes,* causes globular, wart-like galls to form on the upper surface of silver and red maple leaves. Heavy infestations may completely deform leaves but trees are seldom seriously injured.

Maple spindle gall mite, *Vasates aceris-crummena,* produces slender fusiform galls about 5 mm long on the upper surface of sugar and silver maple leaves. Several generations may occur per year.

Pear leaf blister mite, *Eriophyes pyri,* causes formation of small blisters on the undersurface of pear, apple and mountain ash leaves. Several generations occur per year. The mites overwinter under the outer bud scales, resuming activity again in the spring.

Walnut blister mite, *Aceria erinea,* feeds on the underside of walnut and butternut leaves, causing yellow or brown felt-like galls there.

MIDGES

Honeylocust pod gall, *Dasyneura gleditschiae,* is caused by a mosquito-like insect. Eggs are laid on new leaflets and the larvae feeds on the inner surface, causing formation of a pod-like structure. There are several generations a year.

Oak galls The roots, bark, twigs, leaves, flowers and acorns of oaks are very subject to infestation by a large number of gall makers. Each gall has a characteristic appearance and many are quite conspicuous and interesting. Few, however, cause serious damage.

SOIL PESTS

Pests attacking plants below the soil line can be particularly troublesome because, like borers, they are concealed from view, and extensive damage may be inflicted before their presence is detected. The extent of the pest problem, as to area infested and numbers involved, is difficult to determine and the effectiveness of control treatments is equally difficult to assess. Soil pests are readily spread to new areas in balled nursery stock.

Black vine weevil, *Otiorhynchus sulcatus,* is also referred to as the taxus weevil because it is commonly associated with various species of *Taxus.* The larvae is a small, white, legless grub which eats the fibrous roots or strips the bark of larger roots. Infested plants grow slowly, or fail to grow, look dry and off-color, and transplants frequently die without becoming established. The adult is a black snout beetle which hides in the soil litter during the day and cuts crescent-shaped notches in the margins of the needles at night. The beetles are incapable of flight as their wing covers are fused. Arborvitae, hemlock, azaleas and rhododendrons are also attacked.

Japanese beetle, *Popilla japonica,* larvae are "C" shaped milky white grubs about 25 mm in length. The head is brown and it has 3 pairs of legs. It can be identified from other white grubs by the "V" arrangement of the spines on the underside of its abdomen. Larvae generally feed on the fibrous roots of turf but they may also feed on the roots of nursery stock.

Nematodes are tiny, thread-like roundworms that feed and multiply in or on roots of a wide range of plants. Feeding sites are indicated by necrosis (small dead areas) or by local increases in the size and number of cells. Nematodes may also spread soil-borne viruses or facilitate secondary infection by bacteria and fungi. Nematode diseases of plants are controlled by crop rotation, by sterilizing the soil, or by disinfecting dormant planting material. Materials registered in Canada for control of nematodes on ornamentals are Vorlex, chloropicrin, Basamid, Vapam, Telone, and methyl bromide. Use any of these materials according to the directions on the manufacturer's label.

Factsheets are also available on: *Soil and Root Sampling for Nematode Analysis,* Agdex 628; *Nematode Control Guidelines for the Application of Soil Fumigants,* Agdex 628; and, *Soil Fumigants,* Agdex 606.

Areas that harbor potential nematode problems should be treated before planting. For details concerning nematode problems, preplant soil fumigation, and the fumigation of established nurseries, consult your nursery specialist.

Soybean cyst nematode, *Heterodera glycines,* has become a recent concern in southwestern Ontario, particularly in the counties of Kent, Perth, Elgin, Essex and Russell. While most field grown nursery stock are not hosts to this pest, good soil management practices are encouraged to help reduce its spread. Avoid growing nursery stock on fields recently used to produce soybeans. The cysts containing the eggs are easily moved in the soil peds. Reduce soil erosion. Avoid employing equipment that has been used to work soybean fields; soil attached to it may transport the cysts. Many weeds act as host plants to SCN, maintaining good weed control will help reduce populations. Nematicides are not effective against this pest. For more information see OMAF Factsheet, *Soybean Cyst Nematode,* Agdex 141/620.

DISEASES AFFECTING TREES AND SHRUBS

Diseases are grouped below into five main categories: foliage, cankers, vascular wilts, virus and physiogenic (or non-infectious). Brief descriptions of major specific diseases within these categories are included.

FOLIAGE DISEASES

The most obvious signs of disease problems are reflected in the foliage. Very frequently, however, leaves will wilt, turn yellow or partly brown, become spotted, drop off, or become deformed, with diseases which are not directly associated with the leaves at all. This change in foliage condition is sometimes a response to disease problems such as vascular wilts or cankers which occur elsewhere on the plant. Non-infectious diseases such as those caused by drought and air pollution also show up first in the foliage.

The four types of diseases which infect the foliage directly are described below. Rust diseases which cause leaf spots on broadleaved hosts are discussed under **Cankers.**

POWDERY MILDEW

Powdery mildew diseases are caused by fungi. The fungi grow mainly on the surface of the leaves and can be seen as a grayish layer. The disease affects many woody ornamentals including lilac, rose, privet and catalpa. A number of different fungi are responsible; some attack only one or a few kinds of plants while others attack many different plants. The fungus may not spread readily from one kind of plant to another because the strain of the fungus that attacks one type may not attack the other. Powdery mildews produce spores in powdery masses over the leafy surface and are wind-borne to cause secondary infections. They usually become apparent after mid-season when cooler nights are followed by warm days.

Because the fungus grows mainly on the surface on the plant it is readily accessible to fungicides. In some cases, as in roses, severe deformation can occur and control is necessary. In others, such as lilac and privet, the disease is usually not sufficiently damaging to warrant applications of fungicides.

GRAY MOLD (BOTRYTIS BLIGHT)

This fungus disease may affect bulbs, stems, leaves and flowers. High humidity caused by crowding the plants, poor ventilation and leaving old leaves and flowers on the plants or soil surface encourages an outbreak of Botrytis. Symptoms vary from host to host. If the air is very humid, the organism develops a fuzzy gray growth on infected plant parts.

LEAF SPOTS AND ANTHRACNOSE

A great many organisms, mostly fungi, can infect foliage, causing anthracnose or spotting, the coalescence of the spots as infection spreads and, in severe cases, defoliation. Among the more common fungi-causing leaf spots are: *Gleosporium, Alternaria, Cercospora, Phyllosticta, Coccomyces, Marssonina, Gnomonia, Cladosporium, Mycrostroma, Glomerella, Septoria, Mycosphaerella, Guignardia.*

Hosts frequently infected by one or more of the above are catalpa, poplar, walnut, hickory, hawthorn, maple, oak, sycamore, mock orange, mountain ash, and horse chestnut.

Intensity of infection by leaf spotting fungi is determined largely by the weather conditions in the spring, when new growth is tender and succulent. Disease severity increases with the persistence of cool, wet, dull weather.

Leaf spots are usually more unsightly than harmful. However, extensive defoliation in successive years can be debilitating, leading to decline and death. Such is the case with sycamore anthracnose caused by the fungus *Gnomonia plantani.* It can be particularly severe in Ontario and has caused extensive mortality in the eastern United States in past years. This disease also affects the twigs, causing a canker.

NEEDLECAST

Pines, *Pinus*, and firs, *Abies*, are susceptible to needlecast diseases caused by various fungus species of *Hypodermella, Bifusella, Lophodermium* and *Hypoderma*. Infection takes place just after new growth has begun and causes needles to die and fall off, after which the characteristic black fruiting bodies develop along the needles. Needlecast can be of serious consequence in 1- to 4-year-old plants in forest tree nurseries; chemical control is recommended.

SCAB

Diseases which cause scab-like lesions are frequent on rosaceous plants like crabapples. The term "scab" usually describes a disease as it appears on the fruits, although the associated fungi usually also cause a leaf spot similar to rose blackspot. Apple scab, *Venturia inaequalis*, has caused extensive defoliation of crabapples because of the cool, wet weather often encountered in May and June. In most years, apple scab does not require chemical control.

Spraying for Pyracantha scab, *Venturia pyracanthae*, which destroys the fruits of susceptible varieties of Firethorn, is necessary in most years. The cultivars "Orange Glow," "Orange Charmer" and "Mohave" and resistant.

CROWN AND ROOT ROTS

All the fungi described below are soil inhabitants. *Pythium* and *Phytophthora* fungi cause a rotting of the roots and crowns of many plants. The lower part of the leaf and petioles and stems of diseased plants have a water-soaked appearance. Eventually the entire plant will rot off at the ground level. *Rhizoctonia* and *Fusarium* fungi cause a brown cankering of the underground stem and roots of infected plants. *Thielaviopsis* causes a severe rotting of the roots of infected plants. The affected areas are more black in color than brown.

CANKERS

The term "canker" refers to a disease of woody plants that causes the death of bark tissues in relatively localized areas of branches and stems. Death of bark and cambium is followed by death of the underlying wood, and the bark in these areas splits as it dries and can easily be removed, exposing the wood below. Although most cankers are associated with fungi, sun scald and frost can cause similar symptoms. Usually fruiting "pustules" of the disease organism form on the dead bark areas.

A great many canker diseases are caused by weak, parasitic fungi which would be thrown off by normal host reactions under conditions of good health and vigor. However, when the host is in a weak condition due to many causes – drought, lack of hardiness, root disturbance, poor root environment, etc. – it lacks the capacity to "seal off" the infection and the disease gets a foothold on the tissue and can cause serious damage. Cankers of this nature are very common, but are a secondary response and a reflection of host vigor. Plants prone to such cankers are maple, poplar, spruce, willow, daphne, rosaceous hosts, and especially mountain ash. Common, weak, parasitic fungi are species of *Cytospora, Nectria, Valsa, Hypoxylon.*

Some canker diseases are more serious and are, in some cases, aggravated by monoculture growing systems, such as those found in plantations and forest nurseries. In other cases, they result from the sudden introduction of diseases to non-resistant hosts, such as the cankers of white pine blister rust (which is covered under Rusts) and chestnut blight.

Chestnut blight, caused by the introduced fungus *Endothia parasitica,* has effectively destroyed all our native sweet chestnut, *Castanea dentata,* in southern Ontario. There is no satisfactory infection control, although Oriental chestnuts are resistant.

Canker diseases may be either annual or perennial. Their action is not one of merely causing dead patches of bark, but rather of spreading through bark tissues to girdle the stem or branch, killing the distal portions of the plant. Annual cankers can girdle small stems and twigs, such as those of cherry, dogwood and sycamore.

For the most part, cankers are controlled by physical removal of cankered areas, for example, the pruning-out of diseased branches well below the affected areas, or treating stem cankers as wounds to encourage callusing and eventual healing. Where cankers are caused by weak parasites, improving the vigor of the host by cultural means is essential for long-term control. Chemical control is not recommended except as noted below. Considered separately below are the important canker diseases, such as rust, fire blight, and crown gall.

RUSTS

Rust diseases are caused by fungi. The diseases are visible as reddish-brown (rusty) spots on leaves, twigs or stems. Rusts usually have two hosts, spending part of their life cycle on one kind of plant and part on another kind; both are essential for completion of the life cycle. The shape of infected plant parts is frequently distorted, although one host plant may be severely damaged while the other one is only slightly damaged.

The most important group of rust fungi in woody ornamentals is the *Gymnosporangium* rusts. *G. juniperi-virginianae* attacks apple and red cedar *Juniperus virginianae; G clavariaeforme* attacks *Juniperus virginiana, Amelanchier, Aronia, Cydonia* and *Pyrus; G. globosum* attacks *Crataegus* and *Sorbus;* and *G. clavipes* attacks *Crataegus* and *Chaenomeles.*

Cedar-apple rust, *G. juniperi-virginianae,* spends part of its life on red cedar, *Juniperus virginianae* and another part on apple, *Malus.* It may occasionally severely damage flowering crabapple, whereas red cedar is rarely severely affected unless several hundred galls have formed on a single tree. Simply pruning out the galls is the only recommendation on the *Juniperus* hosts. However, a fungicide spray program may be recommended on the broadleaved hosts. Separation of the two hosts as far as is possible reduces the intensity of infection.

White pine blister rust, *Cronartium ribicola,* is a serious disease of 5-needle pines, particularly native white pine, *Pinus strobus.* It infects the needles and eventually causes a perennial canker on branches and stems. Alternate hosts are gooseberries and currants, *Ribes spp.*, where it causes a leaf spot of relatively little significance. Girdled branches of pine should be pruned out before the canker reaches the main stem. Separation of the two hosts is a recommended control. Pine plantations and nurseries should be cleared of *Ribes* for a distance of about 600 metres.

Sweetfern blister rust, *Cronartium comptoniae,* has caused serious losses in nurseries and young plantations of hard pines, especially jack pine, *Pinus banksiana.* The alternate hosts are sweetfern and sweetgale, *Myrica spp.*. Areas around nurseries should be cleared of *Myrica* for several hundred yards. Diseased pines should be destroyed.

FIRE BLIGHT

Fire blight is caused by the bacterium *Erwinia amylovora.* It causes disease in many members of the *Rosaceae* family including *Amelanchier, Aronia, Chaenomeles, Cotoneaster, Crataegus, Malus Photinia, Prunus, Pyracantha, Pyrus, Sorbus* and *Spiraea.* Flowers, spurs, twigs and leaves turn brown and dry out. Dead leaves remain on the plant and appear as though scorched. In warm, humid weather an amber-colored material may exude from recently infected parts. Bleeding perennial cankers may appear on limbs, trunk or roots as the infection spreads. The bacteria are spread from one plant to another by rain, wind and insects.

Control practices include bactericidal sprays at flowering, pruning out cankers one foot below the affected area, and removing sources of infection such as nearby neglected pear trees.

CROWN GALL

This is a bacterial disease caused by the bacterium *Agrobacterium tumefaciens.* It causes galls with an irregular, rough surface ranging up to several centimetres in size, usually occurring near the soil line at the root collar but sometimes found on the roots and aerial parts. It is not a true canker disease but is included in this section because its effect is to disrupt the vascular system to such an extent that girdling results.

A great many plants are susceptible, including rosaceous hosts, euonymus and nut trees. Bacterial entrance is through wounds made by disc, hoe, grafting knife, etc., and the bacterium can remain alive in the soil in the absence of host plants for about 2 years. Chemical control is not recommended. Landscapers should not accept plants from the nursery which have suspicious bumps on the scaffold roots, especially roses and fruits. For nurseries, sanitary propagation practices, such as sterilized grafting tools, are necessary. Infested soils should be replaced, or left fallow for 2 years before re-use.

VASCULAR WILTS

Vascular wilt diseases are caused by fungi or bacteria that enter the water-conducting elements (vascular system) within the plant. Damage to the vascular system reduces the supply of water to the leaves and they wilt. In early stages of wilt, the leaves can often recover temporarily during cool, moist periods, but eventually the wilt becomes permanent and the leaves die. Death of leaves and twigs leads to branch mortality and the eventual death of the entire plant. Important examples of vascular wilt diseases are Dutch elm disease caused by the fungus *Ceratocystis ulmi* and verticillium wilt of maple, linden and catalpa caused by *Verticillium dahliae.*

Since the disease organisms are deep inside the plant, it is impossible to control the disease with a chemical that acts only at surface level. To avoid wilt diseases, use resistant varieties, if available, and plant in soil free from the disease organisms. Diseased plants with verticillum wilt can sometimes be maintained culturally by improving plant vigor through pruning, fertilizing and watering.

Dutch elm disease presents a special case in which attempts are made to control the elm bark beetles that carry the fungus from diseased trees to healthy ones. Removal of diseased and dead trees is essential to the control of beetle populations which breed in them.

VIRUS DISEASES

Virus diseases cannot be controlled directly by chemical means. Most virus diseases are spread by insects or infected tools (pruning equipment, knives, shears). Control of aphids, leafhoppers, mites and other migratory insects will aid in preventing the spread of a virus disease.

Where a virus is suspected, all tools should be disinfected before being used again.

Virus diseases may appear on plants as mottled yellow foliage, misshapened or wrinkled leaves or aborted flowers. In some plants, an overall stunting of growth occurs. Such plants should be removed and destroyed.

PHYSIOGENIC DISEASES

Physiogenic diseases are those not caused by a living organism or virus. They principally affect the foliage and/or proper functioning of root systems. In the latter case, a gradual die-back and even an eventual mortality can occur. Physiogenic diseases are the base causes of vast numbers of plant problems, often predisposing plants to infection by secondary disease organisms. Such disorders and diseases are commonly caused by weather conditions, soil conditions, and man-made physical and chemical disturbances to the air and soil environments.

A common example is leaf and root scorch caused by high levels of salt in the soil, the result of salty irrigation water or from salt applied to remove snow and ice. A late spring leaf scorch of maple and beech has been attributed to sudden exposure of leaves to full sunlight following a wet, cloudy period.

The response to changes in the rooting environment varies with the age and type of plant, and the nature and intensity of these changes. Oak, maple, ash and spruce are particularly sensitive and have a low capacity to adjust to new conditions such as soil compaction, drought, excessive water, change in soil level, root damage during construction, etc.

Control measures for physiogenic diseases primarily depend on eliminating or avoiding the damaging factors (as in salt injury), obtaining resistant plant material or otherwise improving the growing conditions.

INSECT AND DISEASE PEST CONTROL

Host Plant	Pest	Control per 1000 L Water	Remarks
APPLE *(Malus)* Insects:	Aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25 L Metasystox-R 240 SC, 1.75-3.75 L Cygon 480 E, 1.25 L	Treat when adults are first seen and repeat as required.
	Cankerworm	Sevin 80 S, 1.25-2.00 kg Sevin 50 W, 2.0-3.00 kg methoxychlor 240 EC, 4.0 L malathion 500 EC, 2.5 L Thuricide, 1.5-2.0 L Dipel 132 ES, 0.5-1.7 L/ha	Treat when larvae appear (about mid-May). Banding trunks with sticky materials close to the ground will trap egg laying females. See label.
	Eastern tent caterpillar	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg methoxychlor 240 EC, 4.0 L malathion 500 EC, 2.5 L diazinon 500 EC, 925 mL Thuricide, 1.5-2.0 L Dipel 132 ES, 0.5-1.0 L/ha Ambush 500 EC, 70 mL	Prune and destroy overwintering egg masses. Eggs hatch about the time buds break in spring. Treat at this time or at first sign of webs. In light infestations remove and destroy tents which contain larvae. See label.
	Gypsy moth	See under BIRCH.	
	Japanese beetle	See under ROSE.	
	Leafroller	methoxychlor 240 EC, 4.0 L [1]Guthion 240 SC, 1.75-2.5 L [1]Guthion 50 WP, 0.625-.775 kg [1]APM 50 W, 1.0-1.25 kg	Apply to foliage soon after leaves have unfolded (about early June).
	Leafhopper	[1]Guthion 240 SC, 1.75-2.5 L [1]Guthion 50 WP, 0.625-0.775 kg [1]APM 50 W, 1.0-1.25 kg Imidan 50 WP, 1.25 kg Sevin 80 S, 1.25 kg Sevin 50 W, 2.0 kg methoxychlor 240 EC, 4.0 L	Leafhoppers may migrate to nursery stock. Check regularly for infestations and treat as required.
	Oystershell scale and San Jose scale	superior oil, 20 L ethion superior oil, 20 L diazinon 500 EC, 1.25 L malathion 500 EC, 2.5 L	Use superior oil or ethion superior oil as a dormant treatment. Use any of other materials against crawlers about May 25 and again 10 days later.

**Thiodan is very toxic to fish. Do not apply on or near water.*

[1]*Minimum period before reentry is 48 hours. Restricted to use by commercial nursery men only.*

Host Plant	Pest	Control per 1000 L Water	Remarks
APPLE *(Malus)* (continued)	European red mite and Two-spotted mite	superior oil, 20 L ethion superior oil, 20 L Vendex 50 W, 0.5-1.0 kg	Use as a dormant treatment in early spring.
Diseases:	Cedar-apple rust	ferbam 76 WDG, 1.25-2.25 kg Polyram 80 DF, 2.0 kg zineb 80 WP, 1.25 kg Daconil 2787 F, 2.5 L	Make 2 applications to foliage about May 10 and May 20. Spring bud break.
	Fire blight	streptomycin sulfate, 100 ppm Bordeaux mixture, 3-5-1000	Use in areas where fire blight is a recurring problem. Spray at early bloom, full bloom and petal fall.
	Scab	Cyprex 65 WP, 500 g benomyl 50 WP, 550 g + mancozeb 80 WP, 3.25 kg Polyram 80 DF, 2.0 kg Captan 50 WP, 2.0 kg Daconil 2787 F, 2.5 L	First applications at bud break.
ARBORVITAE *(Thuja)* Insects:	Arborvitae leafminer	Cygon 480 E, 2.5 L malathion 500 EC, 2.5 L lindane 25 WP, 4.0 kg	Pruning out infected tips before June may provide some control. Spray in early May or late August with Cygon to control larvae. Use malathion or lindane in June to control moths.
	Bagworm	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Cygon 480 E, 2.5 L diazinon 500 EC, 1.5 L malathion 500 EC, 1.25 L Dylox 80 SP, 1.25 kg Dylox 420 L, 2.5 L Orthene 75 SP, 1 kg Dipel 132 ES, 1.0-2.4 L/ha	Treat when "worms" are small (about early June). In light infestations hand-pick and destroy "bags" during fall and winter or early spring.
	Black vine weevil	See under YEW.	
	Fletcher scale	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L diazinon 500 EC 1.25 L Cygon 480 E, 2.5 L Metasystox-R 240 SC, 1.75 L Orthene 75 SP, 1 kg Dursban 2E, 4 L	Use against crawlers (early July or September).
	Juniper scale	malathion 500 EC, 2.5 L diazinon 500 EC, 1.25 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L Orthene 75 SP, 1 kg Dursban 2E, 4 L	Use against crawlers (about early July and repeat in 10 days).

Host Plant	Pest	Control per 1000 L Water	Remarks
ARBORVITAE *(Thuja)* (continued)	Lecanium scale	malathion 500 EC, 2.5 L diazinon 500 EC, 1.25 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L Orthene 75 SP, 1.0 kg Dursban 2E, 4 L	Use against crawlers (about mid-July).
	Mite	Cygon 480 E, 2.5 L malathion 500 EC, 1.25 L Orthene 75 SP, 1.0 kg Dursban 2E, 750-1000 mL Pentac Aquaflow, 400 mL Vendex, 0.5-1.0 kg Other materials specific for mite control are available. See page 21 re miticides.	More than 2 sprays are required.
	Strawberry root weevil	See under SPRUCE.	
	Tarnish plant bug	Cymbush 250 EC, 280 mL	Control in conifer seedling nurseries. Maximum 3 applications per season. Not for greenhouse use.
Diseases:	Botrytis	Rovral 50 WP 1.2-2 kg/ha	Conifer seedlings: Treat at onset of Botrytis.
	Didymascella leaf blight (Keithia blight)	Dithane M-45, 80 WP, 2.75-3.5 kg	Spray to protect new growth.
ASH *(Fraxinus)* Insects:	Ash flower gall mite	superior oil, 20 L ethion superior oil, 20 L malathion 25 WP, 2.0 kg	Use superior oil or ethion superior oil as a dormant treatment. Use malathion when first blossoms begin to form.
	Borer	*Thiodan 4 EC, 1.25 L Dursban 2E, 1.0 L	Treat trunk and large branches when pupae are observed projecting from tunnels. Repeat application in 2 weeks.
	Lacebug	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L malathion 500 EC, 1.25 L [1]Guthion 240 SC, 1.75-2.5 L [1]Guthion 50 WP, 0.925-1.25 kg [1]APM 50 W, 1.0-1.25 kg Orthene 75 SP, 1.0 kg	Apply to underside of leaves when insects are first observed.
	Fall webworm	Orthene 75 SP, 1.0 kg Dursban 2E, 1.0 L Dipel 132 ES, 0.7-1.7 L/ha	Chemical control is seldom required. Webs and caterpillars may be removed by hand. If sprays are necessary, apply one of the materials listed for Tent Caterpillars. See under APPLE.
	Gypsy Moth	See under BIRCH	

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Host Plant	Pest	Control per 1000 L Water	Remarks
ASH *(Fraxinus)* Insects (continued)	Oystershell scale	superior oil, 20 L ethion superior oil, 20 L diazinon 500 EC, 1.5 L malathion 500 EC, 2.5 L Orthene 75 SP, 1.0 kg Dursban 2E, 4.0 L	Use superior oil or ethion superior oil as a dormant treatment. Use any of other materials against crawlers about May 25 and again in 10 days.
Diseases:	Anthracnose	Dithane M-45. 80 WP, 2.75-3.5 kg	
	Dieback	See Physiogenic Diseases, page 27.	
	Leaf spot	Daconil 2787 F, 2.5 L	First application at bud break.
BEECH *(Fagus)* Insects:	Aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25-1.75 L Metasystox-R 240 SC, 1.75 L [1]Guthion 240 SC, 1.75 L [1]Guthion 50 WP, 0.925-1.25 kg [1]APM 50 W, 1.0-1.25 kg Orthene 75 SP, 1.0 kg Dursban 2E, 750 mL	Treat when aphids are first seen and repeat as needed.
	Cankerworm	See under APPLE. Orthene 75 SP, 1.0 kg	
	Gypsy moth	See under BIRCH.	
BIRCH *(Betula)* Insects:	Aphid	See under BEECH. Also Cygon 480 E, 625 mL	
	Birch leafminer	Di-Syston 15% granules, (see label) Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L malathion 500 EC, 2.5 L Metasystox-R 240 SC, 1.75-3.75 L Cygon 480 E, 500 mL Orthene 75 SP, 1.0 kg	Use any of materials listed in mid-May and again in late June. Cygon or Metasystox-R may be used after mines appear. Cygon 2E may be used as a soil drench or "brush-on" treatment. See label.
	Birch skeletonizer	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg	Collect and destroy fallen leaves. Thoroughly cover underside of leaves about mid-August.
	Bronze birch borer		Maintain tree vigor. Chemical control is very difficult. Cut and destroy weakened limbs by mid-May.
	Gypsy Moth	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L Orthene 75 SP, 850 g Thuricide HPC, 1.6 L Dipel 132 ES, 1.6-2.4 L/ha	Spray when damage first appears and repeat as required. Spray when leaf expansion reaches 40-50%. If necessary, spray about 14 days later.
	Japanese beetle	See under ROSE.	

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Host Plant	Pest	Control per 1000 L Water	Remarks
BOXWOOD *(Buxus)* Insects:	Boxwood leafminers	diazinon 500 EC, 1 L malathion 50, 1.5 L Sevin 50 W, 2.0-3.0 kg Sevin 80 S, 1.25-2.0 kg Cygon 480 E, 1L	
	Boxwood psyllid	Sevin 50 W, 2.0-3.0 kg Sevin 80 S, 1.25-2.0 kg	
Diseases:	Canker		Remove dead branches as soon as they are noticed. Remove and destroy dead leaves which have collected.
BUTTERNUT WALNUT *(Juglans)* Insects:	Walnut blister mite	Kelthane 187.5 EC, 2.5 L	Apply to underside of newly formed leaves.
	Walnut caterpillar	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg methoxychlor 240 EC, 4.0 L malathion 500 EC, 2.5 L	Spray when worms first appear, usually in July. Spray or remove worms clustering on trunk.
CATALPA *(Catalpa)* Disease:	Leaf spot	Sprays usually are not necessary. Destroy or compost fallen leaves. If severe, spray with bordeaux mixture as leaves are unfolding, when leaves reach full size and 2 weeks later. Also see page 25.	
FLOWERING CHERRY CHOKE CHERRY, CHERRY, PLUM *(Prunus)* Insects:	Aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25-1.75 L Metasystox-R 240 SC, 1.75-3.75 L Orthene 75 SP, 1.0 kg Dursban 2E, 750 mL	Treat when adults are first seen and repeat as required.
	Eastern tent caterpillar	See under APPLE. Orthene 75 SP, 1.0 kg Dursban 2E, 1.0 L	
	Japanese beetle	See under ROSE.	
	Leafroller	See under APPLE. Orthene 75 SP, 1.0 kg	
	Peachtree and Lesser peachtree borer	*Thiodan 4 EC, 1.5 L	Make 3 applications, the first in late May or early June, the second 3 weeks later and the third 3 weeks after the second. Apply spray with a gun and cover the trunk and scaffold limbs thoroughly.
	Pearslug	See under APPLE. Orthene 75 SP, 1.0 kg	Almost any insecticide, and even hydrated lime, will give effective control. Apply one of the materials listed for Eastern Tent Caterpillar.

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Host Plant	Pest	Control per 1000 L Water	Remarks
FLOWERING CHERRY, CHOKE CHERRY, CHERRY, PLUM *(Prunus)* Insects: (continued)	Uglynest caterpillar	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg methoxychlor 240 EC, 4.0 L	Chemical control seldom undertaken. A pest only on low-growing shrubs.
Diseases:	Blossom and twig blight	sulfur 90-95 WP, 2.0 kg Captan 50 WP, 2.0 kg Cyprex 65 WP, 500 g benomyl 50 WP, 500 g + mancozeb 80 WP, 2.5 kg Daconil 2787 F, 2.5 L Funginex 190 EC, 750 mL	Spray just before blossom buds open. Repeat in 10 days if wet weather persists.
	Black knot	Prune infected twigs and branches several centimetres below knots and destroy them.	
DOGWOOD *(Cornus)* Diseases:	Twig blight	Prune infected twigs and branches back to healthy wood. Improve cultural conditions.	
	Septoria leaf spot	Daconil 2787 F, 2.5 L	
DOUGLAS FIR *(Pseudotsuga)* Insects:	Cooley spruce gall aphid	See under SPRUCE.	
	Tarnish plant bug	See under ARBORVITAE.	
ELM *(Ulmus)* Insects:	Aphid	See under BEECH.	Do not use Orthene on American elm.
	Cankerworm	See under APPLE.	Do not use Orthene on American elm.
	Elm bark beetle	methoxychlor 240 EC, 80.0 L Dursban 4E, 10.0 L	Treat on suitable days in March and April before leaves are on trees. Apply second treatment around end of July.
	Elm casebearer	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg malathion 500 EC, 2.5 L	Treat foliage in early June.
	Elm flea beetle	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L	Treat foliage in early June to control larvae, or in August to control adult beetles. Causes a shothole appearance to the leaves.
	Elm leafminer	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L Safer's Insecticidal Soap, 1% solution	Treat foliage around first of June to control larvae.

Host Plant	Pest	Control per 1000 L Water	Remarks
ELM *(Ulmus)* Insects: (continued)	Elm leaf beetle	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L methoxychlor 240 EC, 4.0 L *Thiodan 4 EC, 1.25-1.75 L Orthene 75 SP, 1.0 kg	Treat both upper and lower surfaces of leaves.
	European fruit lecanium	superior oil, 20 L ethion superior oil, 20 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L	Use superior oil or ethion superior oil as a dormant treatment in early spring. Use other materials as foliar spray to control crawlers (about mid-July).
	European red mite	See under MOUNTAIN ASH.	
	Gypsy moth	See under BIRCH.	
	Leafhopper	See under HONEYLOCUST.	
Disease:	Dutch elm disease	See Elm Bark Beetle, page 23 and Vascular Wilts, page 26.	
EUONYMUS Insects:	Euonymus scale	Cygon 480 E, 2 L [1]Guthion 50 WP 0.925-1.25 kg	Spray mid-June when nymphs are emerging.
Diseases:	Anthracnose	Daconil 2787, 2.5 L	Apply at spring bud break.
	Crown gall	Dygall, 160 g/50 L See Crown Gall, page 27.	Susceptible plants must be treated prior to exposure to the disease or final field placement.
FIR *(Abies)* Insects:	Balsam twig aphid	malathion 500 EC, 1.25 L Metasystox-R 240 SC, 1.75-3.75 L	Treat when aphids are first seen (about early May).
	Spruce budworm	malathion 500 EC, 2.5 L Sevin 80 S, 0.68-1.36 kg Sevin 50 W, 1.1-2.2 kg Sevin XLR PLUS, 2.3-3.5 L Ambush 500 EC, 35-70 mL Sumithion 50 EC, 0.35-0.56 L	Apply general coverage spray to control larvae (about mid-May). See page 9, Pest Resistance to Insecticides, Fungicides and Miticides.
	Tarnish plant bug	See under ARBORVITAE.	
Diseases:	Botrytis	See under ARBORVITAE.	Seedlings.
	Canker	See Cankers, page 25.	
	Needlecast	Fixed copper 50 WP, 4.0 kg Bordeaux mixture, 8-8-1000 Daconil 2787 F, 2.5 L	Principally a nursery disease. Spray after new growth has started and again 10 days later.

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Host Plant	Pest	Control per 1000 L Water	Remarks
FIRETHORN *(Pyracantha)* Diseases:	Scab	Daconil 2787 F, 2.5 L	Spray at full flower and repeat twice at 14 day intervals. A mid-August spray may be needed under cool, wet conditions.
	Fire blight	See under APPLE.	
HAWTHORN *(Crateagus)* Insects:	Eastern tent caterpillar	See under APPLE. Orthene 75 WP, 1.0 kg	
	Gypsy moth	See under BIRCH.	
	Hawthorn leafminer	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg	Treat undersurface of foliage to control larvae in early June.
Diseases:	Leaf blight *Diplocarpon*	Dithane M-45 80 WP, 2.75-3.5 kg	Spray at bud burst in spring.
	Leaf rust	Daconil 2787 F, 2.5 L	Pre-bloom application.
	Leaf spot *Fabraea*	Daconil 2787 F, 2.5 L	Destroy fallen leaves. Spray as flower buds are opening and repeat if spots develop or use maneb or zineb when buds open, 10 and 20 days later.
	Scab	See under APPLE.	
	Fire blight	See under APPLE.	
HEMLOCK *(Tsuga)* Insects:	Black vine weevil (Taxus weevil)	See under Yew.	
	Eastern hemlock looper	Sumithion 50 EC, 0.56 L or split application at 0.35 L	Split application should be 3-6 days apart.
	Tarnish plant bug	See under ARBORVITAE.	
Disease:	Botrytis	See under ARBORVITAE.	Seedlings.
HICKORY *(Carya)* Insects:	Hickory gall aphid	malathion 500 EC, 1.25 L Dursban 2E, 750 mL	Treat twigs and buds in spring before leaves develop.
	Walnut caterpillar	See under BUTTERNUT.	
	Lacebug	See under ASH.	
Disease:	Leaf spot	See under CATALPA. Also see page 25, Leaf spots and Anthracnose.	

Host Plant	Pest	Control per 1000 L Water	Remarks
HONEYLOCUST *(Gleditsia)* Insects:	Cottony maple scale	See under MAPLE.	
	Leafroller	See under APPLE.	
	Honeylocust mite	Several materials (Kelthane, Morestan, etc.) specific for mite control are available. See page 21 re miticides. Dursban 2E, 750-1000 mL	Treat when mites are present and again in 10 days. Repeat procedure as needed. See label.
	Honeylocust pod gall	Chemical control is very difficult. Malathion or lindane applied to growing tips as growth starts in spring and repeated at 10 day intervals throughout the season may help.	
	Leafhopper	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L methoxychlor 240 EC, 4.0 L Metasystox-R 240 SC, 2.5 L [1]Guthion 240 SC, 1.75-2.5 L [1]Guthion 50 WP, 0.925-1.25 kg [1]APM 50 W, 1.0-2.5 kg Orthene 75 SP, 1.0 kg Dursban 2E, 2.0 L	Treat underside of leaves when leafhoppers are active (about mid-June) and repeat as needed.
	Lecanium scale	See under ARBORVITAE.	
	Rust mite	Kelthane 187.5 EC, 1.25 L	May cause bronzing to the foliage when under heavy infestation. Apply to both surfaces of foliage when mites are active (about mid-June) and repeat as needed.
	Thrips	See under PRIVET.	
HONEYSUCKLE *(Lonicera)* Insect:	Honeysuckle aphid	malathion 500 EC, 1.25 L Metasystox-R 240 SC, 1.75-3.75 L Pirimor 50 WP, 500 g	Life history in Ontario has not been studied. Materials, rates and timing of application are tentative. Apply spray as soon as leaves are expanded, and repeat at least once after a 3 week interval.
HORSE CHESTNUT *(Aesculus)* Diseases:	Leaf scorch	See Physiogenic diseases, page 27.	
	Anthracnose	Daconil 2787 F, 2.5 L	
	Leaf blotch	Daconil 2787 F, 2.5 L	

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Host Plant	Pest	Control per 1000 L Water	Remarks
JUNIPER *(Juniperus)* Insects:	Juniper looper	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Cygon 480 E, 2.5 L	Treat foliage when larvae are active (late August and September).
	Juniper midge	Cygon 480 E, 2.5 L	Treat foliage about mid-May when adults are present and/or drench soil under infested plants in late April.
	Juniper scale	malathion 500 EC, 2.5 L diazinon 500 EC, 1.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L	Use against crawlers (about late June and repeat as needed). Do not use malathion on savin or canaetri junipers.
	Juniper webworm	malathion 500 EC, 2.5 L diazinon 500 EC, 1.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR, 2.3 L methoxychlor 240 EC, 4.0 L	Miticide may be added to prevent build-up of mites if Sevin or methoxychlor is used. See page 21 re miticides. Do not use malathion on savin or canaetri junipers.
	Spruce mite	See under SPRUCE.	
	Tarnish plant bug	See under ARBORVITAE.	
Diseases:	Cedar-apple rust	Prune out galls on infected branches in April. Separate from *Rosaceous* hosts as far as possible. See under Rusts, page 26.	
	Blight (dieback)	fixed copper 50 WP, 4.0 kg Dithane M-45, 80 WP 2.75-3.5 kg	Primarily a nursery disease. Fungus seldom found to be associated with symptoms in older plants in Ontario, suggesting other causes. Spray at start of spring growth and at 10 day intervals until growth ceases. Laboratory diagnosis is necessary to distinguish between *Kabatina* and *Phomopsis*.
LARCH *(Larix)* Insects:	Larch casebearer	malathion 500 EC, 2.5 L	Treat in early May and September.
	Larch sawfly	methoxychlor 240 EC, 4.0 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg malathion 500 EC, 2.5 L Orthene 75 SP, 1.0 kg	Treat foliage when larvae are about half-grown (sometime in July).
	Tarnish plant bug	See under ARBORVITAE.	
	Woolly larch aphid	malathion 500 EC, 1.25 L Metasystox-R 240 SC, 1.75 L	Treat foliage thoroughly when aphids first appear (about early May).

Host Plant	Pest	Control per 1000 L Water	Remarks
LILAC *(Syringa)* Insects:	Lilac borer	*Thiodan 4 EC, 1.25 L lindane 25 WP, 4.0 kg Dursban 2E, 1.0 L	Control is difficult. Treat bark of trunk and large branches, especially around wounds, about mid-May. Repeat twice at 10 day intervals. Cut and destroy infested wood before May.
	Lilac leafminer	Cygon 480 E, 1.25 L malathion 500 EC, 2.5 L Orthene 75 SP, 1.0 kg	For small infestations, pick and destroy affected leaves. Treat as soon as leafminer activity is first observed, or make first application in early June and repeat 6 weeks later.
	Oystershell scale	See under ASH.	
Diseases:	Powdery mildew	sulfur 90-95 WP, 6.0 kg benomyl 50 WP, 500 g + mancozeb 80 WP, 2.5 kg	Spray at 10 to 14 day intervals beginning about August 20.
	Bacterial twig canker		Prune out infected twigs. Kills young twigs in wet springs.
LINDEN or BASSWOOD *(Tilia)* Insects:	Aphid	See under BEECH.	
	Cankerworm	See under APPLE. Orthene 75 SP, 1.0 kg	
	Linden looper	malathion 500 EC, 2.5 L methoxychlor 240 EC, 4.0 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg	Treat foliage at first sign of infestation.
	Two-spotted spider mite	Kelthane 187.5 EC, 2.5 L Metasystox-R 240 SC, 1.75-3.75 L Pentac Aquaflow, 400 mL Vendex 50 W, 0.5-1.0 kg	Treat underside of leaves, beginning in early June and repeat as needed.
	Gypsy moth	See under BIRCH.	
	Japanese beetle	See under ROSE.	
Diseases:	Canker	See Cankers, page 25.	
	Verticillium wilt	See under MAPLE. Also Vascular Wilts, page 26.	
LOCUST *(Robinia)* Insects:	Locust borer	lindane 25 WP, 4.0 kg *Thiodan 4 EC, 1.25 L Dursban 2E, 1.0 L	Remove and destroy heavily infested trees. Maintain tree vigor. Chemical control is difficult. Treat bark or trunk and larger branches to control adult beetles (from mid-August to late September).

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Host Plant	Pest	Control per 1000 L Water	Remarks
LOCUST *(Robinia)* Insects: (continued)	Locust leafminer	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L Orthene 75 SP, 1.0 kg	Treat foliage to control adult beetles (about early July).
	Locust twig borer	Chemical control is not perfected. Cut and destroy infested twigs in August before larvae escape. Rake and destroy leaves in the fall to kill the pupae.	
MAPLE *(Acer)* Insects:	Aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25-1.75 L Metasystox-R 240 SC, 1.75-3.75 L Orthene 75 SP, 1.0 kg Dursban 2E, 750 mL	Treat when adults are first seen and repeat as required. Orthene may cause foliar damage on sugar maple.
	Cottony maple scale	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L Orthene 75 SP, 1.0 kg Dursban 2E, 4.0 L	Use superior oil or ethion superior oil as dormant treatment in early spring but not on sugar and Japanese maple. Use other materials to treat thoroughly about first week of July, and repeat in 10 days. Cover lower surface of leaves with spray. Orthene may cause foliar damage on sugar maple. Malathion should not be used on Crimson King maple.
	Forest tent caterpillar	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L methoxychlor 240 EC, 4.0 L Thuricide 1.5-2.0 L Dipel 132 ES, 0.5-1.0 L/ha Orthene 75 SP, 1.0 kg Dursban 2E, 1.0 L Ambush 500 EC, 70 mL	Treat foliage to control larvae about mid- to late May. See label. Orthene may cause foliar damage on sugar maple. See page 9 re Pest Resistance to Insecticides, Fungicides and Miticides.
	Greenstriped mapleworm	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg	Eggs hatch over an extended period. Spray coverage required from mid-June to late July.
	Gypsy Moth	See under BIRCH.	
	Japanese beetle	See under ROSE.	
	Leafhopper	See under APPLE.	
	Lecanium scale	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L Orthene 75 SP, 1.0 kg Dursban 2E, 4.0 L	Use superior oil or ethion superior oil as a dormant treatment in early spring. Use any of the other materials against crawlers about late July. Malathion should not be used on Crimson King maple. Orthene may cause foliar damage on sugar maple.

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Host Plant	Pest	Control per 1000 L Water	Remarks
MAPLE *(Acer)* Insects: (continued)	Maple bladdergall mite Maple spindlegall mite Crimson erineum mite	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Specific miticide. See page 21 re miticides.	Use superior oil or ethion superior oil as a dormant treatment in early spring, but do not use oil on sugar and Japanese maple. Apply malathion in spring when temperature is 20°C or higher. Malathion should not be used on Crimson King maple.
	Maple petiole borer	No satisfactory chemical treatments have been worked out. Collecting and destroying infested fallen leaf stems before the larvae leave them will help reduce borer populations. The spraying of the foliage and ground beneath the trees with a malathion-methoxychlor mixture as adults are emerging in May might be effective.	
	Maple trumpet skeletonizer	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg methoxychlor 240 EC, 4.0 L	Apply to undersurface of leaves about mid-July to mid-August.
	Sugar maple borer	lindane 25 WP, 4.0 kg	Treat bark thoroughly, particularly near rough bark, throughout July and August. Maintain trees in as vigorous a condition as possible.
	Woolly maple scale	malathion 500 EC, 2.5 L Orthene 75 SP, 1.0 kg	Treat bark and twigs as buds show green in spring. Do not use malathion on Crimson King maple. Orthene may damage foliage of sugar maple.
Diseases:	Canker	See Cankers, page 25.	
	Dieback	See Physiogenic Diseases, page 27.	
	Leaf scorch	See Physiogenic Diseases, page 27.	
	Leaf spot	See under CATALPA. Also see page 25, Leaf spots and Anthracnose.	
	Tarspot		Rake up and discard leaves in fall.
	Verticillium wilt	Prune wilted branches back to undiscolored wood. Thin out remainder of crown. Fertilize and water to promote vigor, especially root growth. Disease often followed by frost cracks and associated cankers. Also see Vascular Wilts, page 26.	
MOUNTAIN ASH *(Sorbus)* Insects:	European red mite	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 1.25 L Metasystox-R 240 SC, 1.75-3.75 L Specific miticides. See page 21.	Use superior oil or ethion superior oil as a dormant spray in early spring. Use other materials about late May. See label.
	Japanese beetle	See under ROSE.	

Host Plant	Pest	Control per 1000 L Water	Remarks
MOUNTAIN ASH *(Sorbus)* Insects: (continued)	Mountain ash sawfly	methoxychlor 240 EC, 4.0 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg malathion 500 EC, 2.5 L *Thiodan 4 EC, 1.25 L Dursban 2E, 1.0 L	Treat foliage to control larvae during June. Repeat treatment in areas where second generation may appear.
	Pearleaf blister mite	ethion superior oil, 20 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg	Apply ethion superior oil as a dormant treatment in the spring. Apply Sevin as a foliar spray.
	Rose chafer	See under ROSE.	
Diseases:	Apple scab	See under APPLE.	
	Canker	See Cankers, page 25.	
	Fire blight	See under APPLE. Also Fire blight, page 26.	
	Leaf spot	See under CATALPA. Also see page 25, Leaf spots and Anthracnose.	
OAK *(Quercus)* Insects:	Aphid	See under BEECH.	
	Cankerworm	See under APPLE. Orthene 75 WP, 1.0 kg	
	European fruit lecanium	See under ELM.	
	Golden oak scale	superior oil, 20 L ethion superior oil, 20 L Cygon 480 E, 2.5 L Orthene 75 SP, 1.0 kg Dursban 2E, 4.0 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L	Use superior or ethion superior oil as a dormant treatment in early spring. Apply other materials against crawlers (about late June).
	Gypsy moth	See under BIRCH.	
	Kermes oak scale	superior oil, 20 L ethion superior oil, 20 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L Orthene 75 SP, 1.0 kg	Use superior oil or ethion superior oil as a dormant treatment in early spring. Use any of the other materials against crawlers beginning in late May and repeat as required.
	Lacebug	See under ASH.	
	Lecanium scale	See under ARBORVITAE.	

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Host Plant	Pest	Control per 1000 L Water	Remarks
OAK *(Quercus)* Insects: (continued)	Oak blotch leafminer	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Orthene 75 SP, 1.0 kg diazinon 500 EC, 1.0 L	Treat foliage to control larvae beginning about first week of June.
	Oak leaf gall		Chemical control usually not necessary.
	Oak leaftier	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg	Apply to control larvae when leaves are partially expanded.
	Oak red mite	Kelthane 187.5 EC, 2.5 L Orthene 75 SP, 1.0 kg	Treat upper surface of foliage from mid-June to mid-July.
	Oak skeletonizer	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg malathion 500 EC, 2.5 L	Collect and destroy leaves in autumn. Treat foliage when damage is first seen, about mid-June, and again in August.
	Orangestriped oakworm	malathion 500 EC, 2.5 L methoxychlor 240 EC, 4.0 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg	Spray in August when larvae are young and concentrated on the lower branches.
	Twig pruner	Chemical control is difficult and not very practical. Collect and destroy fallen twigs by mid-May.	
Diseases:	Chlorosis	Especially Pin Oak. See Fertilizing Landscape Plantings, page 19.	
	Dieback	See Physiogenic Diseases, page 27.	
	Leaf spot	Daconil 2787 F, 2.5 L	Apply when dormant or at bud swell.
PACHYSANDRA *(Pachysandra)* Insect:	Euonymus scale	superior oil, 20 L ethion superior oil, 20 L Metasystox-R 240 SC, 1.75 L Orthene 75 SP, 1.0 kg [1]Guthion 240 SC, 1.75-2.5 L [1]Guthion 50 WP, 0.925-1.25 kg [1]APM 50 W, 1.0-1.25 kg	Use superior oil or ethion superior oil as a dormant treatment in early spring. Use any of other materials against crawlers about mid-June.
PEAR *(Pyrus)* Disease:	Fire blight	See under APPLE.	

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Host Plant	Pest	Control per 1000 L Water	Remarks
PINE *(Pinus)* Insects:	European pine shoot moth	Cygon 480 E, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg diazinon 500 EC, 1.5 L [1]Guthion 240 SC, 2.5 L [1]Guthion 50 WP, 0.85-1.75 kg [1]APM 50 W, 2.0 kg	Apply spray to area between buds on terminals and laterals in latter part of April. Spray terminals about July 10 to prevent injury the following year.
	Gypsy moth	See under BIRCH.	
	Pales weevil	lindane 25 WP, 4.0 kg Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg	Apply to tender bark of seedlings and young shoots of larger trees in April or late August. Remove and destroy old stumps as these provide breeding grounds for adults.
	Pine bark aphid	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 1.25 L Orthene 75 SP, 1.0 kg Dursban 2E, 750 mL	Use superior oil or ethion superior oil on bark of trunk and branches as a dormant treatment in early spring. Do not apply oil on white pine. Apply other materials in late May.
	Pine needle miner	No recommended chemical control.	
	Pine needle scale	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 2.5 L Cygon 480 E, 1.25 L Orthene 75 SP, 1.0 kg	Use superior oil or ethion superior oil as a dormant treatment in early spring. Do not apply oil on white pine. Use any one of other materials against crawlers about late May and early June.
	Pine root collar weevil	lindane 25 WP, 4.0 kg	Apply to bark at base of trunk and soil surface 20 cm out from trunk about mid-June.
	Pine sawfly	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L methoxychlor 240 EC, 4.0 L Cygon 480 E, 1.25 L Orthene 75 SP, 1.0 kg Dursban 2E, 1.0 L Ambush 500 EC, 35-70 mL Sumithion 50 EC, 0.56 L or 0.35 L twice	Treat foliage when larvae are small and first observed feeding. See page 9, Pest Resistance to Insecticides, Fungicides and Miticides. Split application should be made 4-6 days apart.
	Pine spittlebug	Sevin 80 S, 1.2-2.0 kg Sevin 50 W, 2.0-3.0 kg malathion 500 EC, 2.5 L methoxychlor 240 EC, 4.0 L Dursban 2E, 175-300 mL	Treat when spittle mass is first evident (about latter half of May).
	Pine tortoise scale	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W. 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L	Treat twigs to control nymphs about late May.

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Host Plant	Pest	Control per 1000 L Water	Remarks
PINE *(Pinus)* Insects: (continued)	Pine webworm	methoxychlor 240 EC, 4.0 L	Apply spray under sufficient pressure to penetrate webbing of nest. In light infestations hand-pick or prune infested tips.
	Spruce mite	See under SPRUCE.	Do not apply superior oil on white pine.
	Strawberry root weevil	See under SPRUCE.	
	Tarnish plant bug	See under ARBORVITAE.	
	White pine aphid	malathion 500 EC, 2.5 L Cygon 480 E, 2.0 L Orthene 75 SP, 1.0 kg Dursban 2E, 750 mL	Use against active stages in May.
	White pine weevil	lindane 25 WP, 4.0 kg methoxychlor 240 EC, 4.0 L	Spray only vertical terminals in April. Remove and destroy infested leaders in June.
	Zimmerman pine moth	Cygon 480-E, 2 L	Chemical control is difficult. Spray bark thoroughly when overwintering larvae are breaking dormancy, mid-April, or are entering the bark, mid-August.
Diseases:	Canker *(Scleroderris)*	Daconil 2787 F, 2.4-4.8 L	Make first application in spring when new growth is 1-5 cm. Additional applications at 3-4 week intervals.
	Diplodia tip blight	Control is difficult. Sanitation removal of infected branches does not help to reduce infection as spores are also produced on seed cones.	
	Needlecast *(Lophodermium)*	Daconil 2787 F, 2.4-4.8 L Dithane M-45 80 WP, 2.5 kg	Make applications in mid-July to early August before infection occurs. Additional applications at 3-4 week intervals as required.
	Sirococcus tip blight	Daconil 2787 F, 3.6-6 L	See needlecast (spruce) for timing.
	Scirrhia brown spot	Daconil 2787 F, 9.5 L	See needlecast (spruce) for timing.
	Sweetferm blister rust	See Rusts, page 26.	Principally a nursery and plantation disease of 2- and 3-needle pines. Separate pine from *Myrica* co-host as far as possible. Remove infected pines.
	White pine blister rust	See Rusts, page 26.	Separate 5-needle pines from *Ribes* co-host as far as possible. Prune infected branches 30 cm below cankered area. Remove stem cankers according to proper surgical procedures.

Host Plant	Pest	Control per 1000 L Water	Remarks
LONDON PLANE, SYCAMORE *(Platanus)*	Anthracnose	mancozeb 80 WP, 2.75 kg Daconil 2787 F, 2.5 L	Apply up to 3 times depending on cool, wet weather: as buds are swelling, at bud break, and about 7 days later. Prune out and destroy cankered twigs and branches.
POPLAR *(Populus)* Insects:	Forest tent caterpillar	See under MAPLE.	Cut and destroy badly infested trees or branches before the end of June.
	Poplar and willow borer	*Thiodan 4 EC, 1.25 L lindane 25 WP, 4.0 kg Dursban 2E, 1.0 L	Treat bark of trunk and branches about mid-August and September.
	Gypsy moth	See under BIRCH.	
Diseases:	Canker	See Cankers, page 25.	
	Leaf spot	Daconil 2787 F, 2.5 L	Apply at spring bud break.
PRIVET *(Ligustrum)* Insects:	Lilac leafminer	See under LILAC.	
	Privet rust mite	Kelthane 187.5 EC, 2.5 L	Treat both surfaces of leaves when mites are first seen (in late May) and repeat as required.
	Privet sawfly	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg malathion 500 EC, 2.5 L	Treat foliage when feeding damage is first observed.
	Thrips	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L [1]Guthion 240 SC, 1.75-2.5 L [1]Guthion 50 WP, 0.925-1.25 kg Metasystox-R 240 SC, 1.75-3.75 L methoxychlor 240 EC, 4.0 L malathion 500 EC, 2.5 L Orthene 75 SP, 1.0 kg Dursban 2E, 1.0 L	Treat at first sign of infestation and repeat as needed.
Diseases:	Anthracnose and twig blight	No chemical control.	
	Leaf spot	Daconil 2787 F, 2.5 L	Apply during prolonged wet conditions.
QUINCE *(Chaenomeles)*	Fire blight	See under APPLE.	

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Host Plant	Pest	Control per 1000 L Water	Remarks
ROSE *(Rosa)* Insects:	Aphid	See under BEECH. Also Cygon 480 E, 1.25 L	
	Leafhopper	See under HONEYLOCUST.	
	Japanese beetle	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L Imidan 50 WP, 1.25 kg	Spray when adults noticed in early July.
	Rose chafer	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L methoxychlor 240 EC, 4.0 L	Treat foliage thoroughly when beetles are present in June.
	Roseslug	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L	Treat both surfaces of foliage from late May to mid-June.
	Two-spotted spider mite	Kelthane 187.5 EC, 2.5 L diazinon 500 EC, 1.25 L Metasystox-R 240 SC, 1.75 L Cygon 480 E, 1.25 L Orthene 75 SP, 1.0 kg Pentac Aquaflow, 400 mL Vendex 50 W, 0.5-1.0 kg	Treat undersurface of foliage beginning in early June and repeat as needed.
Diseases:	Black spot	Benomyl 50 WP, plus mancozeb 80 WP, 500 g + 2.5 kg Daconil 2787 F, 2.5 L Funginex 190 EC, 1.0 L	Spray at 10 to 14 day intervals beginning mid-May until Mid-August and especially after rain. Shorten intervals in cool, wet weather.
	Botrytis	Botran 75W, 1.75 kg Daconil 2787 F, 2.5 L	Apply prior to lifting for storage. Repeat during storage.
	Crown gall	See under EUONYMUS. See Crown Gall, page 26.	
	Powdery mildew	benomyl 50 WP, plus mancozeb 80 WP, 500 g + 2.5 kg sulfur 90-95 WP, 6.0 kg Meltatox 2.5 L Funginex 190 EC, 1.0 L	Spray at 10 to 14 day intervals beginning about mid-July.
SPRUCE *(Picea)* Insects:	Cooley spruce gall aphid	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Metasystox-R 240 SC, 1.75-3.75 L malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25-1.75 L Dursban 2E, 750 mL	Where possible remove and destroy galls in June. Apply early in spring before bud break or in early October. Cover crevices in bark of terminal twigs and bases of buds thoroughly. Use only wettable powders on blue spruce to avoid discoloration of foliage.

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Host Plant	Pest	Control per 1000 L Water	Remarks
SPRUCE *(Picea)* Insects: (continued)	Eastern spruce gall aphid	superior oil, 20 L ethion superior oil, 20 L malathion 500 EC, 1.25 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L *Thiodan 4 EC, 1.25-1.75 L Metasystox-R 240 SC, 1.75-2.75 L Dursban 2E, 750 mL	For light infestations remove and destroy galls before midsummer. Use superior oil or ethion superior oil as a dormant treatment. Use any of the other materials when aphids are migrating to new shoots (about mid-May). Do not use superior oil or ethion superior oil on blue spruce. Use only wettable powders on blue spruce to avoid discoloration of foliage.
	Pine needle scale	See under PINE.	
	Spruce budworm	malathion 500 EC, 2.5 L Cygon 480 E, 1.25 L Lannate L, 1.25-1.75 L Ambush 500 EC, 35-70 mL Sumithion 50 EC, 0.35-0.56 L Dipel 132 ES, 1.2-2.4 L/ha	Apply general coverage spray to control larvae about mid-May. See page 9 Pest Resistance to Insecticides, Fungicides and Miticides.
	Spruce bud scale	malathion 500 EC, 2.5 L	Spray to control the crawlers about July 10 and repeat after 10 day interval.
	Spruce spider mite	superior oil, 20 L Cygon 480 E, 1.25 L malathion 500 EC, 1.25 L Orthene 75 SP, 1.0 kg Dursban 2E, 750-1000 mL Pentac Aquaflow, 400 mL Vendex 50 W, 0.5-1.0 kg Specific miticide. See page 21 re miticides.	Use superior oil as a dormant treatment in early spring. Apply 2 sprays of other materials at 10 day intervals when mites are present during summer. More than 2 sprays of malathion may be required. Do not use superior oil on blue spruce. Use only wettable powders on blue spruce to avoid discoloration of foliage.
	Spruce needleminer	malathion 500 EC, 2.5 L Orthene 75 SP, 1.0 kg	Nests can be dislodged with a strong stream of water in spring before buds swell or in autumn. Apply to foliage about mid-June and repeat in late June.
	Strawberry root weevil	Belmark 300, 200 mL Ambush 500 EC, 500 mL	Treat some conifer seedlings, especially pine, before treating larger area to ensure absence of phytotoxicity. Seedlings.
	Tarnish plant bug	See under ARBORVITAE.	
	White pine weevil	See under PINE.	
Diseases:	Botrytis	See under ARBORVITAE.	Seedlings.
	Canker	See Cankers, page 25.	

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Host Plant	Pest	Control per 1000 L Water	Remarks
SPRUCE *(Picea)* Diseases: (continued)	Dieback	See Physiogenic Diseases, page 27.	
	Needlecast *(Rhizosphaera)*	Daconil 2787 F, 9.5 L	Make first application in spring when new growth is 1-5 cm. Additional applications at 3-4 week intervals.
	Sirococcus tip blight	Daconil 2787 F, 3.6-6 L	See needlecast (spruce) for timing.
TULIPTREE *(Liriodendron)* Insects:	Tuliptree aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25-1.75 L Metasystox-R 240 SC, 1.75-3.75 L	Treat when aphids first appear and repeat as needed.
	Tuliptree scale	superior oil, 20 L malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L	Use superior oil as a dormant treatment in early spring. Use any one of other materials when crawlers are present (usually in August).
VIBURNUM *(Viburnum)* Insect:	Snowball aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25-1.75 L Metasystox-R 240 SC, 1.75-3.75 L Orthene 75 SP, 1.0 kg Dursban 2E, 750 mL Pirimor 50 WP, 500 g	Treat foliage when aphids are first seen (about mid-May) and repeat as needed.
Disease:	Powdery mildew	Daconil 2787 F, 2.5 L	Apply when fungus first appears.
WALNUT *(Juglans)* Disease:	Leaf spot	See under CATALPA. Also see page 25, Leaf Spots and Anthracnose	
WILLOW *(Salix)* Insects:	Aphid	malathion 500 EC, 1.25 L *Thiodan 4 EC, 1.25-1.75 L Metasystox-R 240 SC, 1.75-3.75 L Orthene 75 SP, 1.0 kg Dursban 2E, 750 mL	Treat when aphids are first seen and repeat as needed.
	Gypsy moth	See under BIRCH.	
	Imported willow leaf beetle	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L methoxychlor 240 EC, 2.5 L malathion 500 EC, 2.5 L Orthene 75 SP, 1.0 kg	Treat at first sign of leaf feeding and repeat as needed.
	Oystershell scale	See under ASH.	
	Poplar and willow borer	See under POPLAR. Also see page 22, Borers.	

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Host Plant	Pest	Control per 1000 L Water	Remarks
WILLOW *(Salix)* Insects: (continued) Disease:	Spiny elm caterpillar	Sevin 80 S, 1.25-2.0 kg Sevin 50 WP, 2.0-3.0 kg malathion 500 EC, 2.5 L	Treat when caterpillars are first seen and still small.
	Willow flea weevil	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg	Treat to control adults about the first of June, or when larvae begin feeding (about mid-June).
	Blight (scab and black canker complex)	No chemical control.	
YEW *(Taxus)* Insects:	Black vine weevil (Taxus weevil)	*Thiodan 4E, 1.25-1.75 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.00-3.0 kg Belmark 300	Treat foliage, bark of trunk, branches and surface of ground near trunk. Treat in last week of June and early July, or whenever grubs are noticed in soil. Do not use Thiodan on Anderson yew. Apply spray in evening. Treat some conifer seedlings, especially pine, before treating larger area to ensure absence of phytotoxicity.
	Fletcher scale	See under ARBORVITAE.	
	Lecanium scale	See under ARBORVITAE.	
	Taxus mealybug	malathion 500 EC, 2.5 L Cygon 480 E, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L diazinon 500 EC, 1.5 L	Use on bark of small branches and twigs to control nymphs (about last week of May to mid-June).

**Thiodan is very toxic to fish. Do not apply on or near water.*

INSECTS AND DISEASES AFFECTING ANNUALS AND PERENNIALS

A continuous, colorful display of annual and perennial plants throughout the growing season requires careful planning, not only in the choice of plant materials, but also in the selection of the proper site, soil preparation, fertilization, and in the control of insects, diseases and weeds.

While this publication is directed toward the control of troublesome diseases, insects and related pests, complete success of bedding plant displays will only come when all the conditions for optimum growth are met.

Display beds for bulbs, perennials and annual plants are generally best situated in sunny areas, free from the competition of the roots and shade cast by larger woody plants. The soil should be of good quality, easily prepared and fertile. A soil test is the best means of determining proper fertility levels.

After the plants have become well established following planting, regular biweekly feedings with a soluble fertilizer such as 20-20-20 will maintain good growth and vigor.

Good cultural practices can help to prevent disease and insect problems. Healthy, weed-free plantings are much less susceptible to attack by disease organisms or troublesome insect pests. However, under certain cultural or climatic conditions such problems will require control. The control can be determined by referring to the list of common diseases and insect pests which follows.

INSECT CONTROL

Pest	Host Plant	Control per 1000 L Water	Remarks
Aphid	Begonia, Centaurea, Dusty Miller, Cineraria, China Aster *(Callestephus)*, Coleus, Geranium *(Pelargonium)*, Impatiens, Salvia, Pansy *(Viola)*, Snapdragon, Zinnia, Chrysanthemum, Campanula, Spring flowering bulbs, Gladiolus, Sunflower	malathion 500 EC, 1.25 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L methoxychlor 240 EC, 4.0 L diazinon 500 EC, 1.0 L Orthene 75 SP, 1.0 kg	Treat when seen. Repeat as required. Diazinon and Orthene not registered on all listed crops. Check label before use.
Beetle, Bug, Caterpillar	Alyssum, China Aster *(Callestephus)*, Geranium *(Pelargonium)*, Impatiens, Marigold *(Tagetes)*, Pansy *(Viola)*, Petunia, Salvia, Snapdragon, Zinnia Chrysanthemum, Delphinium, Iris, Hollyhock *(Althea)*, Phlox, Primula	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L	Treat when seen. Repeat as required.
Black vine weevil	Begonia	No chemical control available.	
Borer	Iris	Cygon 480 E, 2.0 L	Spray when new foliage is 12-15 cm tall. Apply to soil around infested plants. Rake up and destroy old leaves.
Corn earworm	Ageratum, Gladiolus	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg methoxychlor 240 EC, 4.0 L	Treat as soon as insect is first seen.
Cutworm	Delphinium, Gladiolus	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L	

Pest	Host Plant	Control per 1000 L Water	Remarks
Leafhopper	China Aster *(Callestephus)*, Marigold *(Tagetes)*, Zinnia, Hollyhock *(Althea)*	Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L methoxychlor 240 EC, 4.0 L	Spray when insects appear.
Leafminer	Columbine *(Aquilegia)*, Chrysanthemum, Delphinium	malathion 500 EC, 2.5 L	Apply as soon as miners are noticed.
Leaf skeletonizer	Hollyhock *(Althea)*	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg methoxychlor 240 EC, 4.0 L	Treat when seen. Repeat as required.
Mealybug	Begonia, Coleus, Geranium *(Pelargonium)*, Pansy *(Viola)*, Primula	malathion 500 EC, 2.5 L	
Midge	Chrysanthemum	malathion 500 EC, 2.5 L	
Mite	Begonia, China Aster *(Callestephus)*, Coleus, Geranium *(Pelargonium)*, Pansy *(Viola)*, Snapdragon, Zinnia, Chrysanthemum, Delphinium, Gladiolus, Hollyhock (Althea), Phlox, Primula	malathion 500 EC, 1.25 L Kelthane 187.5 EC, 2.5 L Cygon 480 E, 1.25 L Pentac Aquaflow, 400 mL	Treat as required, and repeat in 5-7 days. Cygon not registered for use on gladiolus.
Slug	Geranium *(Pelargonium)*, Marigold *(Tagetes)*, Pansy *(Viola)*, Campanula, Delphinium, Primula	metaldehyde bait or 15% dust	Treat soil around plants.
Sawfly	Pansy *(Viola)*	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg	Treat when seen. Repeat as required.
Thrips	Begonia, Campanula, Chrysanthemum, Gladiolus, Iris (In garden)	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L methoxychlor 240 EC, 4.0 L Orthene 75 SP, 1.0 kg	Treat when seen. Repeat as required. Begin spraying Gladiolus when young plants are 30 cm tall and repeat at two-week intervals.
	Gladiolus (In storage)	Dust with 5% Sevin dust.	Use dry storage at 2-4°C.
Tobacco budworm	Ageratum	malathion 500 EC, 2.5 L Sevin 80 S, 1.25 kg Sevin 50 W, 2.0 kg methoxychlor 240 EC, 4.0 L	Treat as soon as insect is first seen.
Tarnish plant bug	Gladiolus	malathion 500 EC, 2.5 L Sevin 80 S, 1.25-2.0 kg Sevin 50 W, 2.0-3.0 kg Sevin XLR PLUS, 2.3-3.5 L	Apply when flower buds begin to develop. Repeat just before buds open.

Pest	Host Plant	Control per 1000 L Water	Remarks
White fly	Ageratum, Begonia, Coleus, Geranium *(Pelargonium)*, Salvia, Chrysanthemum	*Thiodan 4 EC, 1.25-1.75 L	
White grub, Wireworm	Gladiolus	No chemical control available.	Do not plant Gladiolus for 2 years following sod as white grub and wireworm are likely to be prevalent.

DISEASE CONTROL

Anthracnose	Pansy *(Viola)*, Snapdragon	Folpet 50 WP, 2.0 kg	Apply at 5 day intervals.
Blight, Leaf blight	Zinnia, Primula, Snapdragon	ferbam 76 WP, 1.25-2.0 kg Folpet 50 WP, 2.0 kg	
Bacterial blight, Scab	Gladiolus (In storage)	No chemical control.	Destroy infested corms.
Bacterial soft rot	Iris	No chemical control.	Use clean or pasteurized soil and clean rhizomes. Also see Iris borer control.
Botrytis, Botrytis leaf spot, Fire (Botrytis)	Pansy *(Viola)*, Snapdragon, Geranium *(Pelargonium)*, Spring flowering bulbs	captan 50 WP, 2.0 kg Rovral 50 WP, 1.0 kg Daconil 2787 F, 1.5-1.7 L	
Botrytis leaf and flower spot	Gladiolus (In garden)	Daconil 2787 F, 2.5 L	
Bulb rot	Spring flowering bulbs	No chemical control.	Use clean stock and clean or pasteurized soil.
Club root	Alyssum	No chemical control.	Use clean stock and clean or pasteurized soil.
Damping off	Alyssum	Vitavax Captan 30 W, 250 g	Avoid overcrowding.
Downy mildew	Centaurea, Cineraria, Dusty Miller, Snapdragon	Fixed copper 50 WP, 4.0 kg Bordeaux mixture, 4-4-1000 benomyl 50 WP, 500 g + mancozeb 80 WP, 2.5 kg	
Fusarium wilt	Marigold *(Tagetes)*, Gladiolus (In garden)	No chemical control.	Use clean stock only and clean or pasteurized soil. Remove infected plants.

**Thiodan is very toxic to fish. Do not apply on or near water.*

Pest	Host Plant	Control per 1000 L Water	Remarks
Gray mold (Botrytis)	Chrysanthemum	zineb 80 WP, 1.25 kg captan 50 WP, 2.0 kg	
	Chrysanthemum, Azalea, Fushia, Pelargonium, Geranium, Hedera, Impatiens, Iresine primula	Rovral 50 WP, 1.0 kg	
Leaf spot	Chrysanthemum	Folpet 50 WP, 2.0 kg zineb 80 WP, 2.0 kg captan 50 WP, 2.0 kg	
	Begonia, Coleus, Impatiens, Marigold *(Tagetes)*, Salvia, Campanula, Delphinium, Hollyhock *(Althea)*, Iris, Phlox	Folpet 50 WP, 2.0 kg	
Powdery mildew	Begonia, Snapdragon, Chrysanthemum, Campanula, Delphinium, Phlox	sulfur 6.0 kg benomyl 50 WP, 500 g + mancozeb 80 WP, 2.5 kg Funginex 190 EC, 1.0 L	
	Zinnia	Daconil 2787 F, 2.5 L	
Root rot	Ageratum, China Aster *(Callestephus)*, Geranium *(Pelargonium)*, Snapdragon, Zinnia	Truban, 270-375 g	Use clean or pasteurized soil. Practice crop protection.
Rust	Chrysanthemum	sulfur, 6.0 kg ferbam 76 WP, 1.5-2.0 kg	
	Hollyhock *(Althea)*, hydrangea	Daconil 2787 F, 2.5 L	Early spring during infection periods.
	Ageratum, Centaurea, Cineraria, China Aster *(Callestephus)*, Dusty Miller, Pansy *(Viola)*, Salvia, Columbine *(Aquilegia)*, Campanula, Hollyhock *(Althea)*, Iris, Primula	sulfur, 6.0 kg	
Scab	Pansy *(Viola)*	No chemical control.	

Pest	Host Plant	Control per 1000 L Water	Remarks
Soft rot, Corm rot, Hard rot, Dry rot	Gladiolus (In storage)	No chemical control.	Destroy infected corms. Avoid warm, humid storage conditions.
Stem canker	Delphinium	No chemical control.	Use clean or pasteurized soil.
Stem rot	Begonia	Truban, 270-375 g Quintozene 75 WP, 1.25 kg/100 m^2	Use as a soil drench.
	China Aster *(Callestephus)*, Impatiens, Petunia, Snapdragon, Zinnia	Truban, 270-375 g	Use clean or pasteurized soil. Use as a soil drench.
Tip blight and Leaf spot	Dracaena *(Cordyline)*	No chemical control.	Remove affected leaves. Avoid wetting foliage.
Wilt	Alternanthera, Centaurea, Cineraria, Dusty Miller, China Aster *(Callestephus)*, Impatiens, Snapdragon, Chrysanthemum	No chemical control.	Use clean or pasteurized soil.
Yellows	China Aster *(Callestephus)*, Marigold	No chemical control.	Virus-like disease transplanted by leafhoppers which results in poor flowering, followed by distorted flowers, yellowing leaves and eventually death. Destroy infected plants as soon as noticed.

PUBLICATIONS

Publications and factsheets are available free of charge (unless otherwise stated) from the Ontario Ministry of Agriculture and Food, Consumer Information Centre, 801 Bay St., Toronto, Ontario M7A 2B2 or from your local County Agricultural Office; or from the extension horticulturist serving your area.

PUB. NO.	OMAF TITLE
29	*Drainage Guide for Ontario*
64	*Insect and Disease Control in the Home Garden*
65	*Energy Conservation in Ontario Greenhouses*
75	*Guide to Weed Control*
313	*Mist Propagation*
334	*Rootstocks for Fruit Trees*
358	*Herbaceous Perennials*
373	*Orchard Sprayers*
384	*Production Recommendations for Turf*
483	*Pruning Ornamentals*
494	*Nut Culture in Ontario*
501	*Farm Drainage*
505	*Ontario Weeds ($5.00 per copy)*
515	*Farm Ponds*
527	*Windbreaks on the Farm*
529	*Weed Control in Lawns and Gardens*

AGDEX #	OMAF FACTSHEET TITLE	ORDER NUMBER
141/628	*Soybean Cyst Nematode*	90-119
210/22	*Care of Fruit Tree Nursery Stock from Nursery to Planting*	88-013
210/24	*Orchard Grafting Methods*	90-102
210/24	*Repair Grafting*	88-029
210/681	*Rodent and Deer Control in Orchards*	89-122
211/36	*Apple Root Stocks*	90-118
212/624	*Peach Tree Borers*	83-072
270/776	*Security Lighting Effects on Landscape Plants*	76-025
273	*Lawn Renovation*	90-045
273/626	*Grubs in Lawns*	84-049
275	*Planting Trees in the Landscape*	89-115
275/24	*Preventing Fruit Formation on Ornamental Trees*	85-026
275/636	*Common Disorders of Broad-Leaved Trees*	90-013
510	*Soil Compaction*	88-082
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572	*Soil Erosion*	87-040
573	*Control of Soil Erosion*	86-092
573	*Grassed Waterways*	82-063
573	*Gully Erosion Control*	88-059
606	*Soil Fumigants*	81-038
607	*Guide to Handling and Applying Herbicide to Protect Water Supplies and Reduce Personal Exposure*	87-044
607	*Management of Pesticides on the Farm*	88-083
607	*Pesticide Container Rinsing*	87-057
607	*Pesticide Contamination of Farm Water Supplies*	86-077
607	*Reducing Pesticide Drift and Crop Damage*	88-118
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628	*Soil and Root Sampling for Nematode Analysis*	81-040
628	*Nematode Control Guidelines for the Application of Soil Fumigants*	81-049
640	*Cocklebur*	83-003
642	*Pigweed (Redroot, Green, Smooth)*	83-059
642	*Wild Mustard*	88-085
744	*Field Sprayer Calibration*	88-129
744	*Flat-Fan Nozzle Tips for Field Weed Sprayers*	89-110
752	*Drain Problems*	84-017
752	*Drainage Legislation*	89-166
752	*The Drainage Act Loans*	86-052

*When ordering publications please refer to the Agdex number and title.
*For complete list, including Factsheets, obtain most recent listing from source indicated.

AGRICULTURE CANADA PUBLICATIONS

1516 *Gypsy Moth*
1718 *Major Pests of Birch and Maple Trees*
1727 *New Winter-Hardy Roses and other Flowering Shrubs*
A53-1697-1980E *Trees and Shrubs of the Dominion Arboretum ($14.95 per copy)*

Available from Communications Branch and Publications Distribution, Agriculture Canada, Ottawa K1A 0C7.

THE METRIC SYSTEM

Linear Measures (length)
10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Square Measures (area)
100 m x 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)
Dry Measure
1000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)
Liquid Measure
1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight — Volume Equivalents (for water)
(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Weight Measures
1000 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry — Liquid Equivalents
1 cm^3 = mL
1 m^3 = 1000 L

CONVERSION TABLES – IMPERIAL TO METRIC

Length		
inch	=	2.54 cm
foot	=	0.30 m
yard	=	0.91 m
mile	=	1.61 km
Area		
square foot	=	0.09 m^2
square yard	=	0.84 m^2
acre	=	0.40 ha
Weight		
ounce	=	28.35 g
pound	=	453.6 g
ton	=	0.91 tonne
Volume (dry)		
cubic yard	=	0.76 m^3
bushel	=	36.37 L
Volume (liquid)		
fluid ounce (Imp.)	=	28.41 mL
pint (Imp.)	=	0.57 L
gallon (Imp.)	=	4.55 L
gallon (U.S.)	=	3.79 L
Temperature		
°F	=	(°C x 9/5) + 32
Pressure		
pound per square inch	=	6.90 kPa

CONVERSION TABLES – METRIC TO IMPERIAL

Length

1 millimetre (mm)	=	0.04 inch
1 centimetre (cm)	=	0.40 inch
1 metre (m)	=	39.40 inches
1 metre (m)	=	3.28 feet
1 metre (m)	=	1.09 yards
1 kilometre (km)	=	0.62 mile

Volume (liquid)

1 millilitre (mL)	=	0.035 fluid ounce
1 litre (L)	=	1.76 pints
1 litre (L)	=	0.88 quart
1 litre (L)	=	0.22 gallon (Imperial)
1 litre (L)	=	0.26 gallon (U.S.)

Weight

1 gram (g)	=	0.035 ounce
1 kilogram (kg)	=	2.21 pounds
1 tonne (t)	=	1.10 short tons
1 tonne (t)	=	2205 pounds

Pressure

1 kilopascal (kPa)	=	0.15 pounds/square inch

Area

1 square centimetre (cm^2)	=	0.16 square inch
1 square metre (m^2)	=	10.77 square feet
1 square metre (m^2)	=	1.20 square yards
1 square kilometre (km^2)	=	0.39 square mile
1 hectare (ha)	=	107,636 square feet
1 hectare (ha)	=	2.5 acres

Volume (dry)

1 cubic centimetre (cm^3)	=	0.061 cubic inch
1 cubic metre (m^3)	=	1.31 cubic yards
1 cubic metre (m^3)	=	35.31 cubic feet
1000 cubic metres (m^3)	=	0.81 acre-foot
1 hectolitre (hL)	=	2.8 bushels

Speed

1 metre per second	=	3.28 feet per second
1 metre per second	=	2.24 miles per hour
1 kilometre per hour	=	0.62 mile per hour

Temperature

°C = (°F – 32) x %

APPLICATION RATE CONVERSIONS
(approximate)

Metric to Imperial (Approximate)

litres per hectare x 0.09	=	gallons per acre
litres per hectare x 0.36	=	quarts per acre
litres per hectare x 0.71	=	pints per acre
millilitres per hectare x 0.015	=	fluid ounces per acre
grams per hectare x 0.015	=	ounces per acre
kilograms per hectare x 0.89	=	pounds per acre
tonnes per hectare x 0.45	=	tons per acre

Imperial to Metric (Approximate)

gallons per acre x 11.23	=	litres per hectare (L/ha)
quarts per acre x 2.8	=	litres per hectare (L/ha)
pints per acre x 1.4	=	litres per hectare (L/ha)
fluid ounces per acre x 70	=	millilitres per hectare (mL/ha)
tons per acre x 2.24	=	tonnes per hectare (t/ha)
pounds per acre x 1.12	=	kilograms per hectare (kg/ha)
ounces per acre x 70	=	grams per hectare (g/ha)

Liquid Equivalents

Litres/Hectare		Approximate Gallons/Acre
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

Dry Weight Equivalents

Grams or Kilograms per Hectare		Approximate Ounces or Pounds per Acre
100 grams	=	1½ ounces
200 grams	=	3 ounces
300 grams	=	4¼ ounces
500 grams	=	7 ounces
700 grams	=	10 ounces
1.10 kilograms	=	1 pound
1.50 kilograms	=	1¼ pounds
2.00 kilograms	=	1¾ pounds
2.50 kilograms	=	2¼ pounds
3.25 kilograms	=	3 pounds
4.00 kilograms	=	3½ pounds
5.00 kilograms	=	4½ pounds
6.00 kilograms	=	5¼ pounds
7.50 kilograms	=	6¾ pounds
9.00 kilograms	=	8 pounds
11.00 kilograms	=	10 pounds
13.00 kilograms	=	11½ pounds
15.00 kilograms	=	13½ pounds

EMERGENCY AND FIRST-AID PROCEDURES FOR PESTICIDE POISONING

Become familiar with the chemicals you are using. Keep a list of common names in case of accidents or emergencies. This information can be found on the product labels and cross-referenced in this publication.

If a pesticide has come in contact with the skin or has been spilled on clothing, remove the clothing and wash the skin thoroughly with soap and warm water. Repeat the wash.

If a pesticide has come in contact with the eyes, rinse them with plenty of clean water for 15 minutes.

If a person suspects poisoning from exposure to a pesticide by swallowing, inhalation, or contact with skin or eyes, read the label on the pesticide container and carry out the first-aid treatment suggested.

IMMEDIATELY AFTER THE FIRST-AID TREATMENT HAS BEEN GIVEN, WRAP THE PATIENT IN A COAT OR BLANKET AND RUSH HIM TO THE NEAREST HOSPITAL. TAKE THE LIST OF CHEMICAL COMMON NAMES WITH YOU AND IDENTIFY THE ONES BEING USED.

IF A PERSON IS FOUND UNCONSCIOUS OR LAPSES INTO UNCONSCIOUSNESS, CALL AN AMBULANCE IMMEDIATELY.

EMERGENCY ADVICE ON PESTICIDE POISONING IS AVAILABLE BY CONTACTING THE POISON INFORMATION CENTRES: THE NAMES AND TELEPHONE NUMBERS ARE LISTED UNDER EMERGENCY CALLS AT THE FRONT OF EACH BELL TELEPHONE DIRECTORY.

Fill in the following:

MY LOCAL POISON INFORMATION CENTRE TELEPHONE NUMBER IS:

_____ _____

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